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ECONOMIC ASSESSMENT OF PROPOSED REVISIONS TO REGULATION 308

SYNTHESIS REPORT

JULY 1990

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SYNTHESIS REPORT

Report Prepared by:
VHB Research and Consulting

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Ontario Ministry of the Environment

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EXECUTIVE SUMMARY

Background

The Ministry of the Environment has proposed several important revisions to Regulation 308 of the Environmental Protection Act (Stopping Air Pollution at its Source, Ministry of the Environment, November 1987.) If the revisions are adopted, direct emission limits would be imposed on all air pollution sources of an appreciable size, and the existing ambient air quality criteria would be replaced by ambient air standards.

Other changes included in the proposed revisions relate to air quality modelling, standard setting procedures and measures to address specific problems.

To assist in the deliberations about the proposed revisions, the Ministry commissioned an economic assessment of the likely benefits, costs and consequences of implementing the proposals. The benefits will come from reduced emissions of contaminants that affect human health, flora and fauna, restrict visibility, and damage manufactured materials. The costs of the proposals stem mainly from additional requirements for abatement and monitoring by industrial and municipal sources. The Ministry of the Environment will also need extra staff and facilities to administer the more stringent regulation.

Purpose of the Assessment

The main purpose of this assessment is to provide the Ministry of the Environment and other interested parties with information that will be useful for deciding how best to implement the proposed revisions to Regulation 308. To this end, the assessment considered five implementation scenarios that differ according to the required levels and timing of emissions reduction and enhanced monitoring.

Unprecedented Endeavour

There is an extensive literature relevant to specific aspects of this economic assessment. However, this assessment is unprecedented in the number and combination of sectors, sources, contaminants and monitoring and abatement technologies considered and the size of the geographic area. It is also unusual to undertake such an assessment while a regulation is being developed or revised rather than after it has been implemented.

Scope

The assessment considered 96 individual contaminants emitted from 2,185 industrial plants, 1,200 dry cleaners and 200 restaurants. The abatement and monitoring technologies relevant to each source were identified and costs estimated. All this information was mapped, together with detailed information on the population and resources at risk. For most of the analysis, a time horizon of the year 2005 was adopted.

Results

The results provide a useful indication of the benefits, costs and consequences of the proposed revisions to the regulation despite inadequacies in the data. Standard present value methods were used to compare the benefits and costs. The cost estimates were based on a single set of assumptions relating to technologies, removal efficiencies, and capital and operating expenses. Two sets of benefit estimates were prepared, low and central, reflecting different values for some of the exposure-response functions and for the significance of some of the health impacts. The range of net benefits estimated for each implemantation scenario and discount rate shows that, in all cases, net benefits are negative in the low case, and positive in the central case.

Estimated Net Benefits (1986 $ billion) - Low and Central Case

Discount Rate	Scenario A Initial 3 tier - Scenario D Initial 2 tier		Scenario B more stringent		Scenario C less stringent		Scenario E slower implentation	
	Low	Central	Low	Central	Low	Central	Low	Central
0%	-1.6	15.8	-2.9	17.8	-2.9	6.7	-3.8	6.8
5%	-2.5	7.2	-3.9	7.7	-2.8	2.4	-3.0	2.4
7%	-2.6	5.3	-4.0	5.4	-2.7	1.5	-2.7	1.6
10%	-2.6	3.4	-4.8	3.2	-2.5	0.7	-2.3	0.8

To interpret these results it is important to note that the cost estimates are reasonably complete and, possibly, are on the high side since very little provision was made for process change as a means of compliance with the revised regulation. In contrast, measured benefits are only a portion of the likely total benefits since data limitations imposed serious constraints on the range of benefits which could be estimated.

Implementation scenario A offers greater net benefits than scenario C in the low and central cases. This suggests that quite stringent implementation of the proposed revisions is attractive since the additional measured benefits exceed the additional compliance costs.

A comparison of the net benefits of scenario A with those of the even more stringent scenario B suggests that an increase in stringency may eventually add more to compliance costs than to the measurable benefits.

Scenario E is identical to scenario A except that the revised regulation is implemented more slowly under E. A comparison of the net benefits for these scenarios suggests that a significant proportion of the net benefits achieved under scenario A in the central case will not be realized at the slower rate of implementation of scenario E. Even in the low case, scenario A is more attractive than scenario E.

Benefits

The proposed revisions would reduce significantly the contaminants emitted into the atmosphere:

Contaminant Group	Estimated 1987 Emissions from Reg. 308 Sources at 100% Capacity (tonnes)	Reduction Depending on Scenario %
Nitrogen oxides	55,000	12 - 30
Particulates	115,000	49 - 77
Sulphur dioxide	96,000	17 - 66
Volatile organic compounds	109,500	23 - 85
Others	42,000	0 - 100

Note: Estimates are based on the assumption that revised Reg. 308 will not supersede the Countdown Acid Rain Program.

Since most of the sources of these emissions are in highly populated areas, most of the benefits are due to reduced health risks, reduced damage to manufactured materials and increased visibility. Owing to a lack of information on cause and effect, only part of these benefits could be estimated and valued. For health effects alone, it was estimated that the economic value of the benefits for which the necessary information was available would range from about $80 to $700 million a year, depending on the stringency of controls, the assumed values for reductions in health risks (all in 1986$), and an assumption that all existing sources would be bought into compliance with the revised regulation within five years. The value of reduced damages to materials was estimated to range from $235 to $825 million a year. Very substantial benefits from improved visibility were estimated but as the methodology was based on California experience, these were considered to be not directly applicable to the Ontario context.

Costs

In the first five years of implementation, when all new and existing sources are being brought under the revised regulation, it is estimated that the additional annual costs for abatement and monitoring will range from $550 million to $1,300 million, depending on the stringency of the emission standards. Beyond this initial period only new sources of emissions will be affected, and the additional annual capital costs will range from $60 million to $150 million (all in 1986$).

Operating costs start out as a small proportion of annual capital costs (7-14%) but soon rise to over 50% by the end of the five-year implementation period. After that, annual operating costs, which must be paid each year on all installed equipment, far exceed annual capital costs, which are only paid by new plants since all existing plants will be in compliance.

During the five-year period of implementation, the Ministry's extra administration costs are estimated to be $16 million a year. Once all firms are in compliance, these additional costs fall to $500,000 a year. A few years later they rise again sharply when the requirement for the renewal of all Certificates of Approval takes effect.

The costs associated with a considerably slower rate of implementation were also estimated.

Consequences

The consequences of these additional costs for the national and provincial economies were considered through macroeconomic simulation using well-established econometric models. It was found that much depends on the level of controls, and hence costs, as well as on the rate at which the revisions are implemented.

In each case where the revisions would be fully implemented within five years, the extent of the economic consequences was different, but the overall pattern was similar. During the first two years there would be a stimulus to the national and provincial economies resulting in increases in output, investment and employment. As many as 15,000 additional jobs might be created in Ontario in the second year as a result of the added expenditures required for complying with the revised regulation and administering it.

It is expected that firms will attempt to pass on their higher costs for abatement and monitoring by raising their prices. Some of their customers, especially those that can buy elsewhere at lower prices, will respond by reducing their purchases. In addition, some capital that would have been invested in new plant and equipment will be diverted to abatement and monitoring.

The net result of these effects will be a decrease in production and employment in year three and beyond. This decrease will be greater than the stimulus to the economy in the earlier years. Moreover, if Ontario is the only jurisdiction to strengthen its air pollution controls (an assumption which underlies these results), these negative effects will be felt entirely in this province, with Quebec and Manitoba being the main beneficiaries of these adjustments.

Though the negative effects are real and will be spread directly or indirectly across most sectors of the provincial economy, at 1% or less they represent only a small reduction in growth. Except perhaps in petroleum refineries, output and employment will not be reduced below their present levels. There will be a slowing in growth, not an absolute reduction in output.

One sector which will expand considerably if the proposed revisions to Regulation 308 are implemented is the environmental protection industry. It appears that demands for equipment from this industry will at least double in the first five years. Demands for construction will add another 20 to 40% to the sales of the relevant construction and design industries. It is quite conceivable that the suppliers of abatement and monitoring equipment in Ontario will not be able to meet these increases in demand and that there will be a shortage of the skilled labour required for installation, operation and maintenance.

A Comparison with the U.S.A

It was beyond the scope of the assessment to consider the implications for Ontario of possible regulatory changes elsewhere, particularly in the U.S.A. If abatement and monitoring requirements are made more stringent in the jurisdictions with which Ontario competes, the negative economic consequences outlined above will be mitigated.

Acknowledgements

This report is a synthesis of the work undertaken by several companies:

-	The DPA Group Inc.	Benefits
-	SENES Consultants Limited	Abatement Costs
-	SENES Consultants Limited	Monitoring, Auditing and Administration Costs
-	Informetrica Limited and James Hickling Management Consultants Limited	Economic Consequences

Each of these companies prepared reports on which this synthesis is based. The DPA Group and SENES Consultants received assistance from other companies whose work is also acknowledged: RCG/Hagler, Bailly Inc., Monenco Consultants Limited, Wx Research House Inc., American Management Systems Inc., Canviro/CH_2M Hill, Independent Measurement and Technology Inc., and Keir Consultants Inc.

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Peter A. Victor
Project Coordinator

CHAPTER 1

INTRODUCTION

1.1 Background to the Proposed Revisions to Regulation 308

Since 1971, one of the main statutory means of controlling air pollution in Ontario has been the Environmental Protection Act (1971) and the regulations pursuant to the Act, in particular, Regulation 308.

Regulation 308 specifies the maximum permitted concentration of numerous contaminants at a point of impingement from a source of contaminant (other than a motor vehicle). The regulation also shows how the concentration of a contaminant at a point of impingement may be calculated.

To complement the point-of-impingement standards, the Ontario Ministry of the Environment has established a set of ambient air quality criteria, expressed as ambient concentrations. These criteria are designed to protect human health, flora and fauna. When they are exceeded, it is indicative of an air pollution problem but is not, in itself, an offence under the Environmental Protection Act.

Regulation 308 also includes several other important sections for protecting air quality. It permits the Ministry of the Environment to establish an Air Pollution Index which can be used by the Minister to order that emissions be curtailed when the index exceeds specified levels. The regulation also prohibits all emissions of any contaminants that may cause discomfort to persons, loss of enjoyment of normal use of property, damage to property, or interference with the normal conduct of business.

Despite the generally good record of air pollution abatement in Ontario, several problems have been identified in the discussion paper on Air Pollution Regulation 308 released by the Ministry of the Environment in November 1987 (Stopping Air Pollution at Its Source). The problems include a failure to account fully for:

- long-range transport and deposition;

- very short-term and very long-term effects;
- bioaccumulation, persistence, additive effects and synergistic effects.

Other problems identified in the discussion paper relate to air quality modelling, lack of public participation in the regulatory process, and weaknesses in dealing with experimental situations and changes in land use.

Under the existing regulatory system the Ministry has attempted to remedy these shortcomings in a discretionary manner and by relying on the general provisions of the Environmental Protection Act, in particular section 13, which is a comprehensive prohibition against discharging contaminants that could cause damage. The Ministry has introduced additional regulations to deal, when necessary, with specific problems. The most important example is the set of regulations that limit the emission of sulphur dioxide and nitrogen oxide from electricity-generating stations and non-ferrous smelters to reduce acid precipitation.

With the publication of Stopping Air Pollution at Its Source, the Ministry announced its proposal to strengthen the regulation of air pollution in Ontario, chiefly by revising Regulation 308 of the Environmental Protection Act. For the first time in Ontario it is being proposed that direct emission limits be imposed on all air pollution sources of an appreciable size. These limits would be based on an assessment of the optimum performance that various levels of abatement technology could achieve. Also, the Ministry's ambient air quality criteria would be replaced by ambient air standards.

Two alternative regulatory schemes are described in Stopping Air Pollution at Its Source. The first recognizes three levels of control, one each for high-hazard, medium-hazard and low-hazard pollutants. The second scheme distinguishes between only two levels of control: high-hazard and medium- or low-hazard pollutants. However, the precise levels of control that the Ministry is contemplating are not specified, and the details of the proposed revisions to Regulation 308 will not be decided until after further discussions with interested parties and various technical analyses.

With the publication of the discussion paper, the Ministry began a broad-based review of its proposals. Starting in January 1988, Ministry officials visited many parts of the province to discuss the proposals at open houses. In addition, the Ministry invited written submissions and received 97 of these from companies, industry associations, municipalities, environmental groups and individuals. The Ministry has also maintained close contact with the several other ministries most interested in environmental issues, all of whom have representatives on the Inter-ministerial Committee on Economy and Environment.

To support the discussion process further and in keeping with the recommendations in the Report of the National Task Force on Environment and Economy (September 24, 1987), the Ministry commissioned a series of studies for an economic assessment of the proposed revisions to Regulation 308. These studies estimate the benefits expected from the revised regulation; the additional costs for abatement, monitoring, and administration; and the impact of these costs on the provincial economy and on the sectors most likely to be adversely affected by the higher costs.

In addition to these individual studies, the Ministry commissioned this report to provide a synthesis of the entire economic assessment, including a comparison of the benefits, costs and consequences of the proposed revisions to Regulation 308. This synthesis report draws extensively on the reports of the individual studies, which readers may wish to consult for more detailed information.

1.2 An Overview of the Economic Assessment

The purpose of the economic assessment of the proposed revisions to Regulation 308 is to provide the Ministry of the Environment and other interested parties with information that will be useful for deciding how best to implement the proposals.

The economic assessment was divided into four studies:

1. Estimation of the Additional Public Benefits of Implementing the Proposed Revisions to Regulation 308

   Objective: To identify and, where possible, quantify and value the additional benefits expected from implementation of the proposed revisions to Regulation 308.

2. Estimation of the Additional Abatement Costs for the Proposed Revisions to Regulation 308

Objective: To estimate the additional abatement costs (including reduction, recycling, reuse), for each major industrial sector, waste disposal companies and municipalities, of compliance with the proposed revisions to Regulation 308.

3. Estimation of the Additional Monitoring, Auditing and Administration Costs for the Proposed Revisions to Regulation 308

Objective: To estimate the additional costs of stack testing that may be required for compliance with the proposed revisions to Regulation 308;

To estimate the additional costs of ambient monitoring to ensure compliance with the proposed revisions to Regulation 308;

To estimate the additional costs to the Ministry of the Environment for audit and administration of the proposed revisions to Regulation 308.

4. Estimation of the Economic Costs and Consequences of Implementing the Proposed Revisions to Regulation 308

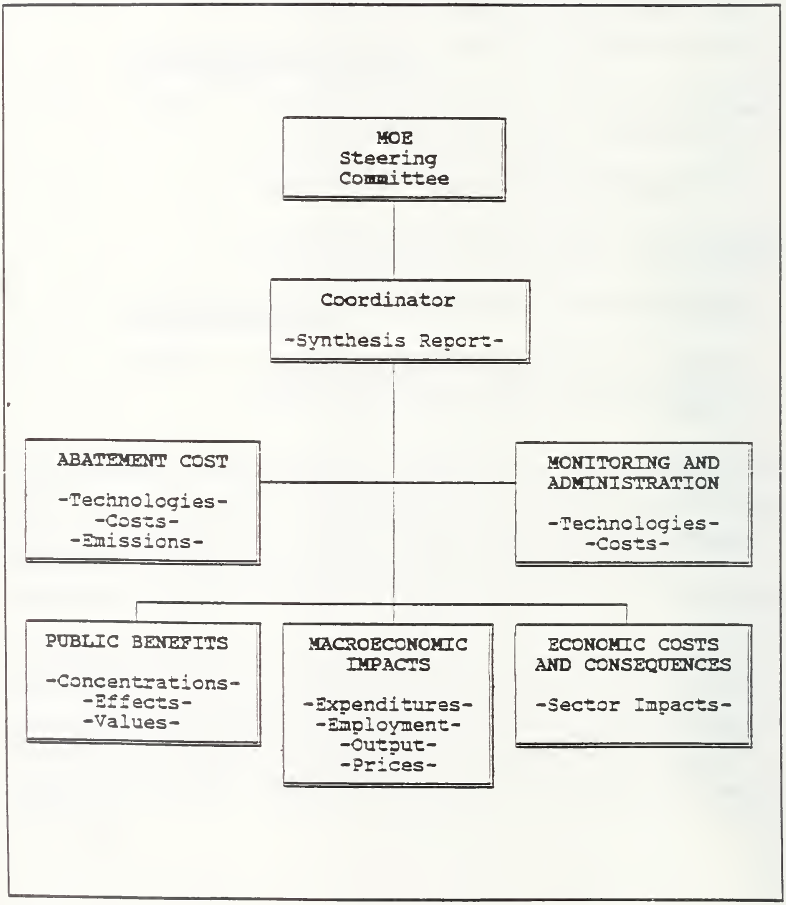
Objective: To assess the economic costs and consequences for the economy, individual industrial sectors, government, employment and the consumer, of implementing the proposed revisions to Regulation 308.

Six separate technical reports were prepared for each of these studies (the first and fourth studies were each divided into two components). The studies began at the end of February 1988, under the overall direction of a Ministerial Steering Committee. At the request of the Ministry and with considerable assistance from Ministry officials, the studies were substantially complete in six months. Subsequently, additional work on benefits was commissioned to improve the accuracy of the estimates.

Although the individual studies of which this economic assessment is comprised were undertaken by different, independent consultants, a considerable effort went into ensuring that they were done in a mutually consistent fashion. The Steering Committee of the Ministry of the Environment, working through a coordinator, guided each of the components along complementary lines. As well, the consultants responsible for each study met several times as a group and maintained frequent contact with one another.

Figure 1-1 shows the organizational structure of the economic assessment and identifies the principal outputs of each technical report. More detailed flow diagrams describing each study and their interrelationships are provided in Appendix A.

Figure 1-1
Organizational Structure



There is an extensive literature relevant to specific aspects of this economic assessment and there have been many individual studies similar to the components identified in Figure 1-1. However, this assessment is unprecedented in terms of the number and combination of sectors, sources, contaminants, monitoring and abatement technologies considered and the size of the geographic area. The timing of the assessment is also unusual in that it is intended to inform the development of a revised regulation rather than merely examine a regulation that has already been implemented.

1.3 Scope and Key Assumptions

It will become apparent in subsequent chapters of this report that the lack of specificity in the proposed revisions to Regulation 308 and the absence of readily available data necessitated the use of a liberal mix of assumptions, professional judgment and often very incomplete information. As a result, the estimates derived in each of the studies and presented in this synthesis report are tentative, incomplete and subject to considerable uncertainty. Nevertheless, it is the view of those responsible for the individual studies and of the Steering Committee that the results provide a useful indication of the magnitude and significance of the benefits, costs and consequences of the proposed revisions to Regulation 308.

To assist the reader in fully understanding the scope and key assumptions of this assessment, several features of the way it was undertaken are discussed in this chapter.

1.3.1 Interpreting the Proposed Revisions to Regulation 308

As noted earlier, in Stopping Air Pollution at Its Source the Ministry of the Environment has proposed a revision of the way in which activities that cause air pollution are regulated in Ontario: point-of-impingement standards would be replaced by emission standards, and the air quality criteria would become standards. Although the discussion paper sets out various principles and procedures which might be followed in establishing the new emission standards, the actual standards have not been decided upon.

To a large extent, the benefits, costs and consequences of the proposed revisions to Regulation 308 will depend greatly on what these emission standards are. Consequently, it was necessary to develop assumed standards that could form the basis of the analysis. These assumed emission standards were worked out in consultation with staff of the Ministry, but they only suggest what the new Regulation 308 might look like and have no official status. They should not be interpreted as a statement of the Ministry's intentions with respect to any particular contaminant or sector, but only as a reasonable basis on which to assess the proposed revisions to Regulation 308. In so far as the real standards differ from those assumed, the estimates of benefits, costs and consequences will also be different from those developed in the assessment and reported here.

Rather than choose a single set of assumed emission standards it was decided to examine several alternatives. A comparison of the alternatives shows how the benefits, costs and consequences will vary according to the specific way in which the proposed revisions are implemented. It is not likely that the actual implementation of the changes to Regulation 308 will correspond to any one of the five scenarios considered. However, by examining a range of possibilities, the economic assessment will help the Ministry make a more informed decision.

1.3.2 Coverage of Contaminants

In principle, all substances released to the atmosphere are contaminants subject to regulation under the Environmental Protection Act. It is not known how many substances are emitted in Ontario, but the number is probably in the tens of thousands. The vast majority are not believed to cause problems because they are harmless, the quantities released are too small or they are adequately covered within a broader class of contaminant (e.g. suspended particulate matter).

This assessment considered only those contaminants believed by the Ministry to represent the greatest risk to health and the environment or to be the most expensive to control. Stopping Air Pollution at Its Source lists 253 contaminants for which ambient air quality standards are proposed. Even this list proved too long, and on the advice of the Ministry a short list of 96 contaminants was developed, including 10 contaminants not mentioned in the proposed ambient standards reported in Stopping Pollution at Its Source. (See Appendix B.)

The exclusion of a large number of contaminants from this economic assessment imposes a greater limitation on the estimation of benefits than of costs. Much of the estimating of costs was done for broad categories of contaminants rather than individual substances. The reason is that the same technologies are generally used for abating or monitoring groups of contaminants such as particulates or volatile organic compounds (VOC's), regardless of the specific particulates or VOC's concerned. Often, however, the damage caused by these contaminants depends on which particulate or VOC is being emitted, on which other contaminants may be present, and on characteristics of the contaminant such as particle size and temperature. It follows that if it is not known which contaminants are being emitted, there will be greater errors in the estimation of benefits than costs.

1.3.3 Coverage of Affected Sectors

The proposed revisions to Regulation 308 could affect firms with plants located in Ontario that are involved in any type of productive activity. However, most of these plants emit only insignificant quantities of the contaminants considered in this assessment, and one of the proposals is that the revised regulation not apply to "very small (or de minimus)" emission sources. Accordingly, the assessment concentrated on 2,185 plants in the industrial sectors believed to be the main sources of contaminants, plus 1,200 dry cleaners and 200 restaurants. (See Appendix C.)

1.3.4 Emission Levels and Capacity Utilization

Much of the analysis was based on estimated emission levels assuming that production capacity was operating at 100%. This assumption may overstate the level of emissions of some contaminants and to a lesser extent, the reduction in emissions attributable to the proposed revisions to Regulation 308.

1.3.5 Planning Horizon

The Ministry of the Environment proposes to bring all existing sources of the top two categories of contaminants (in a two- or three-tier system) into compliance with the new regulation within five years of promulgation. New sources of all contaminants would be covered by the new regulation as soon as it is promulgated. Consequently the costs will be incurred within a relatively short time. There will also be increased abatement and monitoring costs extending far into the future, and eventually equipment brought in to meet the requirements of the new regulation will have to be replaced.

For the purposes of this assessment, a planning horizon to 2005 was selected. This is more than adequate for tracking the effect of the additional costs on the Ontario economy. However, it is also short enough to permit the assumption that equipment installed to meet the new regulation will not need to be replaced, and so the future costs of replacing worn-out equipment are excluded from the assessment.

The complexities of estimating benefits necessitated an even more cavalier approach to the question of time. All the analysis of benefits was based on a comparison of estimated emissions in 1987 with the levels that would have obtained in that year under each of several scenarios when the proposed revisions to Regulation in 308 are fully implemented. This approach provides a good indication of the benefits achievable from the regulatory reforms. However, in reality it will be some years before the estimated benefits are realized.

1.3.6 Compliance with the Regulation

To assess of the proposed revisions to Regulation 308, it is necessary to compare the benefits, costs and consequences expected of the existing Regulation 308 with those expected from the new regulation. Such a comparison is complicated by the fact that there is no way of knowing the extent to which the multitude of emission sources will in future comply with the regulation.

Rather than attempt to forecast compliance rates, it was decided to assume that compliance for the existing and new regulation would be 100%. As well as making the assessment more manageable, this assumption has the merit of assessing the benefits, costs and consequences associated with the Ministry's intentions that underlie the proposed revisions to Regulation 308. In practice, the benefits, costs and consequences of the proposed revisions may be less than the assessment predicts. How much less will depend on the resources devoted by the Ministry to administration as well as the willingness of emitters to comply with the law.

1.3.7 Other Air Pollution Regulations

In order to capture the incremental effect of the proposed revisions to Regulation 308, it is important to recognize that there are already several regulations under the Environmental Protection Act that supersede the existing Regulation 308. Chief among these are the regulations making up the Countdown Acid Rain Program, which require non-ferrous smelters and Ontario Hydro to reduce their emissions of sulphur dioxide and nitrogen oxides. With the agreement of the Ministry of the Environment, the assessment of the proposed revisions to Regulation 308 was based on the assumption that the proposed revisions will not supersede these existing regulations except where the discussion paper explicitly states that they will do so.

1.3.8 Other Environmental Protection Measures in Ontario

Over the past two years the Ministry of the Environment has introduced new regulations to control pollution (i.e. the MISA program) and hazardous waste disposal (Regulation 309). These regulations, which are already coming into effect, may require many of the same firms that are subject to Regulation 308 to incur considerable costs. Although it is the combined impact of these costs that will determine the consequences for firms and the economy at large, this economic assessment analyses only the costs associated with the proposed revisions to Regulation 308. Similarly, the environmental benefits associates with these other initiatives are not considered in this assessment.

1.3.9 Other Jurisdictions

The consequences of increased costs for pollution control in Ontario will depend partly on the extent to which Ontario firms are placed at a competitive disadvantage with respect to firms in other parts of Canada and abroad. Though pollution control regulations in all jurisdictions with which Ontario firms compete have been tightened and will probably continue to be tightened, it was beyond the scope of this assessment to consider systematically the effect of these changes. However, by drawing on U.S. information on the costs and efficiency of abatement technologies that are already in use, it is reasonable to believe that the costs developed in this assessment are not completely out of line with costs already being imposed in some other jurisdictions.

1.3.10 Monitoring and Abatement Technologies

For practical reasons only abatement and monitoring technologies currently available were considered in this assessment. Furthermore, most of the abatement technologies are "end-of-pipe" devices that remove substantial portions of one or more contaminants. Other measures, such as internal process changes, product redesign, and raw material substitution were only considered in an extremely partial fashion because these measures are usually plant-specific and cannot be addressed in an overview study of this sort.

1.3.11 Ambient Air Quality Modelling

The proposed revisions to Regulation 308 include the use of a new air quality model. This model was used in estimating the benefits in this assessment. However, it was not feasible to use the model on a site-specific basis to check whether compliance with the point source control standards assumed in the study will be adequate to achieve the proposed ambient air quality standards. Indeed, in the estimation of benefits it was found that some parts of the province would be exposed to concentrations higher than the proposed standards even after the most stringent levels of control are implemented.

1.3.12 Effect of Environmental Benefits on the Economy

Reductions in air emissions are expected to improve the quality of life in Ontario in a variety of ways. Such improvements can benefit the economy by attracting firms and migrants and by stimulating outdoor recreation and tourism. Reductions in health care expenses and in damage to construction materials, agriculture, and forests also have economic implications that go beyond an assessment of their value.

Though it is not too difficult to identify the possible effect of environmental benefits on the economy, it was beyond the scope of this assessment to do so systematically and quantitatively. Consequently the treatment of benefits and costs in this assessment is asymmetric in that both costs and benefits are valued in economic terms whereas only the consequences of the increased costs are examined in detail.

1.4 The Implementation Scenarios

Stopping Air Pollution at Its Source explains the new approach to controlling air pollution that is being proposed by the Ministry of the Environment and presents several options for its implementation. For the purposes of this economic assessment, five scenarios were developed based on the number of levels of control, the rate of implementation and the required level of abatement. These scenarios are summarized in Table 1-1.

As seen in Table 1-1, the contaminants were grouped so that the same level of abatement in any scenario applies to all contaminants in the same group. It should be noted that the Ministry intends to classify each contaminant individually. The use of contaminant groups, which were developed in consultation with Ministry officials, was merely a convenient way of classifying the contaminants in sufficient detail to conduct the economic assessment. The classification should not be interpreted as a statement of the Ministry's intentions regarding the proposed revisions to Regulation 308. Rather, the purpose of examining several scenarios is to assist the Ministry in formulating the revised regulation, which in all likelihood, will differ considerably from any single scenario.

Table 1-1: **Implementation Scenarios for Regulation 308**

	Scenario			
	A	B	C	D
Contaminant Group	Initial 3-Tier	More Stringent	Less Stringent	2-Tier
Volatile organic compounds (Odorous and non-odorous)				
Chlorinated	1	1	2	1
Aliphatics	3	2	3	2
Aromatics	2	1	3	2
Esters/alcohols/ethers/aldehydes/ketones	2	1	2	2
Mercaptans	3	2	3	2
Particulates:				
Organics	1	1	2	1
Metals	1	1	2	1
Other	2	1	3	2
Semi-volatile organics	2	1	3	2
Pesticides	2	1	3	2
Corrosives				
Acids	2	1	3	2
Bases	2	1	3	2
Other	2	1	3	2
Other 2	1	3	2	

Phasing in for each of the above scenarios is assumed to follow the same pattern as shown below. A fifth scenario (E) was also considered; it is identical to scenario A but is phased in more slowly.

	Scenario	
Phasing in	A,B,C,D	E
New facilities	1989	1989
Existing Facilities		
Contaminant Group		
1	1989-1993	1989-2003
2	1989-1993	2004-2008
3	1989-1993	2004-2013

Note: Level 1 contaminants will be controlled to a rate achieved by the best emission control system available.

Level 2 contaminants will be controlled to a rate achieved by the best control technology generally available, taking reasonable economic and other factors into consideration.

Level 3 contaminants will be controlled at the minimun level demonstrated as acceptable at similar sources.

CHAPTER 2
BENEFITS

2.1 Introduction

The proposed revisions to Regulation 308 will result in a reduction in the emission of contaminants that pose a threat to all forms of life, including human. These contaminants can reduce yields from agriculture, forestry and fishing, damage buildings and manufactured materials and reduce visibility. The benefits from the proposed revisions to Regulation 308 will come from a reduction in these kinds of undesirable impacts.

This chapter outlines the approach taken to the difficult task of estimating these benefits in terms of bio-physical units (e.g. number of cancers avoided, reduction in crop damage). Where available, the quantitative estimates of benefits were used as the basis for valuing the benefits in monetary terms. Though there are serious methodological difficulties in assigning a monetary value to health and environmental benefits, when comparing benefits with costs, it is an obvious advantage to use the same units of measurement. Quite properly, the decision on how to implement the proposed changes to Regulation 308 will be based on other considerations as well. However, in so far as the benefits can be estimated and valued, so doing can only aid the decision-making process, providing the estimates and values are well understood.

2.2 Methodology

Figure 2-1 illustrates the problem of identifying and estimating benefits. It shows a source of contaminant emissions that would be affected by the proposed revisions. For most contaminants there are other sources that would not be affected by Regulation 308. These include motor vehicles, forests (a major source of some types of hydrocarbon gases), point sources governed by other regulations, sources too small to be affected by Regulation 308 and emissions that come from outside the province.

The contaminant emissions are dispersed around the source over an area assumed not to exceed 24 km in radius, although some portion of the emissions would be dispersed over greater distances. Hence, in this assessment the ambient concentration of a contaminant at any point is largely determined by the dispersion of emissions from nearby sources. The effects of a contaminant on humans and the environment depend on the ambient concentration, derived from all surrounding sources.

The proposed revisions to Regulation 308 will reduce the emissions from specified sources, and this will reduce the ambient concentration in the area surrounding the source, assuming that emissions from other sources do not change. The change in ambient concentration can be estimated from the change in emissions from Regulation 308 sources. However, the level of ambient concentration of a given contaminant cannot be determined without knowing the emissions from all non-Regulation 308 sources. These emissions are usually not known.

The benefits of a lower ambient concentration depend on the specific contaminant, the resources it affects, the resources present in the area where the air quality is improved, and the relationship between contaminant concentration and damage.

The relationship between a reduction in ambient concentration and human health or other environmental benefits usually takes one of two forms. The benefits may depend on the change in concentration, in which case they can be calculated from the change in the estimated concentration of the contaminant sources. Alternatively the benefits may depend on level of concentration; that is, there may be no observable effects for concentrations below a specific threshold.

Where benefits only occur as a result of changes in concentration above a threshold value, it was necessary to estimate the contribution of emissions from non-Regulation 308 sources. In Figure 2-1, if the threshold is T_1, benefits occur as a result of the reduced emissions from Regulation 308 sources as seen in the graph on the right. But if the contribution of non-Regulation 308 sources is not known, as in the graph on the left, no benefits are attributed to the reduced emissions. If the threshold is T_2, benefits can be calculated in either case, but they will probably be underestimated if they are calculated from the change in concentration due to emissions from Regulation 308 sources (the graph on the left).

If benefits only occur at concentrations above a specific threshold, they can only be estimated if the contribution of non-Regulation 308 sources is known. If the contribution of these sources cannot be determined, only the change in the resources exposed can be calculated. This change may or may not represent a benefit.

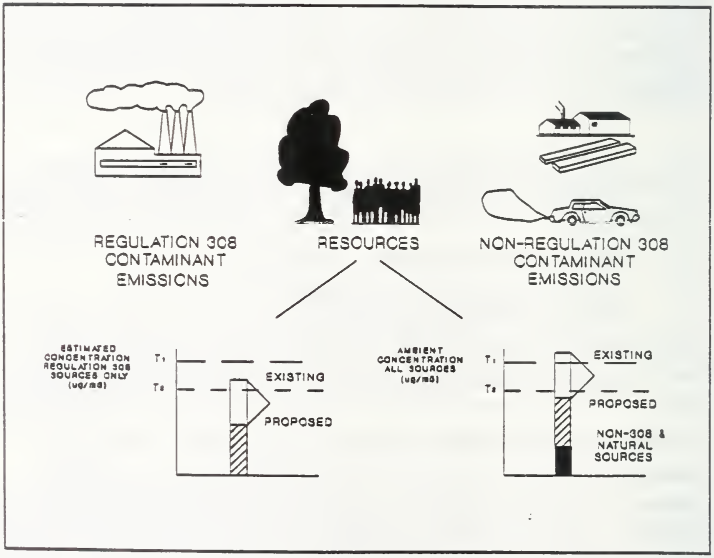
Several tasks were undertaken in preparing the estimates of the benefits associated with the proposed revisions to Regulation 308. Estimates of the benefits accruing through the implementation of proposed revisions to Regulation 308 were derived in two stages. The purpose of the first stage was to estimate total benefits under the assumption that all stack sources have the same emission characteristics. This stage was comprised of seven discrete steps:

- estimate reduction in point source emissions of the contaminants in question.
- estimate changes in ambient concentrations of these contaminants under the various scenarios.
- identify and map the population and resources at risk.
- estimate changes in the exposure of population and resources at risk.
- derive unit values for the resources exposed.
- multiply the changes in exposures by the unit values on an area-by-area basis.
- aggregate the results to estimate total benefits (i.e. reduction in risk or damage).

The second stage deals with particulate matter and sulphur dioxide (SO_2). It is built on the methodological base established for stage one. The simplifying assumption that all stack characteristics were similar was dropped. Instead, for each industry detailed stack characteristics and emissions data for a stratified sample of establishments were applied to the industry as a whole. The resulting emissions data were then used to re-estimate the total benefits associated with revisions to Regulation 308. The results in this synthesis report are based on these revised estimates of benefits.

Figure 2-1

Estimating Benefits


REGULATION 308 CONTAMINANT EMISSIONS
RESOURCES
NON-REGULATION 308 CONTAMINANT EMISSIONS
ESTIMATED CONCENTRATION REGULATION 308 SOURCES ONLY (ug/m3)
T1
T2
EXISTING
PROPOSED
AMBIENT CONCENTRATION ALL SOURCES (ug/m3)
T1
T2
EXISTING
PROPOSED
NON-308 & NATURAL SOURCES

2.3 Reduction in Emissions

As the proposed revisions to Regulation 308 will be implemented over several years, emissions will be reduced at a corresponding rate. In order to estimate the benefits from the eventual total reduction in emissions, 1987 was used as the base year, and all benefits were estimated with respect to that year and assumed to last indefinitely. This assumption avoided the need to employ detailed projections of the various populations at risk, which would have complicated the estimation process considerably. In section 2.13, consideration is given to the rate at which these benefits are likely to be realized over time.

Table 2-1 summarizes the expected reduction in total emissions from sources considered in the assessment for each of the five scenarios as compared with estimated 1987 emission levels assuming 100% capacity utilization. (The evaluation of benefits from reduced emissions was based on actual utilization factors for 1986). For scenario E, only those reductions expected by the year 2003 are included. Figure 2-2 presents the same information - the percentage reductions for scenarios A, B, C and E (to 2003) - in the form of a bar chart for ease of comparison.

Note that exiting emissions and potential reductions associated into particulate matter and SO_2 are derived from an analysis separate from that conducted for the other contaminants. In these two special cases, existing emissions were estimated on the basis of actual capacity utilization rather than full capacity utilization, as assumed for the other emission estimates. This does not, however, affect the percentage reduction from existing levels represented by emissions under the five scenarios.

Figure 2-2

Estimated Reduction in Emissions

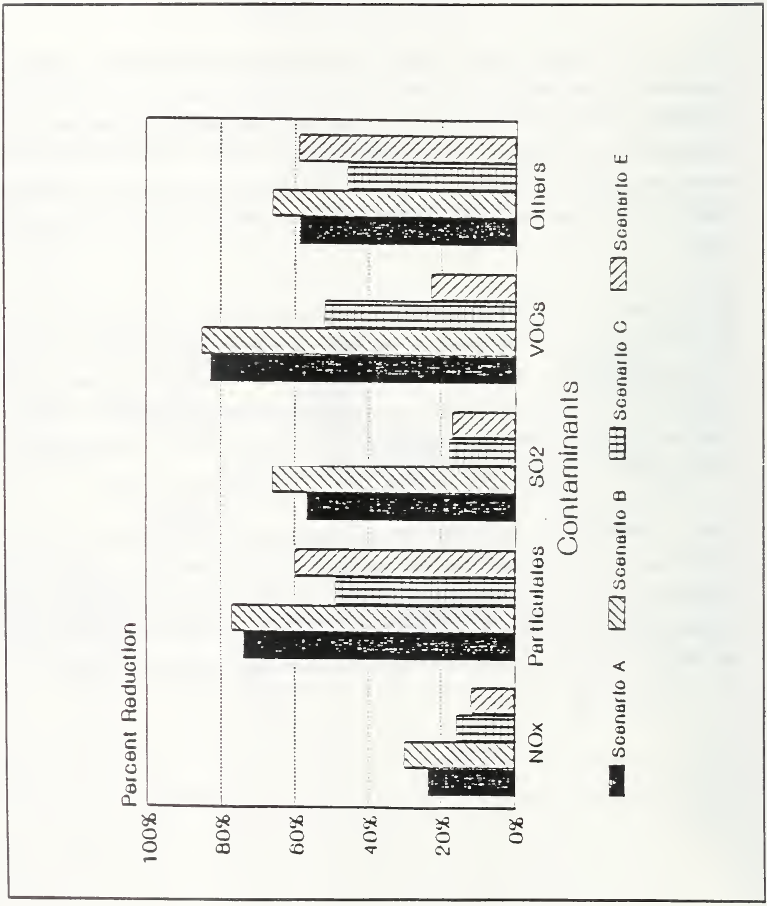


Table 2-1: Emission Reduction by Scenario from Sources Considered in the Assessment

Contaminant	Estimated Emissions in 1987 (tonnes) at 100% capacity utilization	A	B	C	D	E*
		(percent reduction from 1987 level)				
Aldehydes	47	99	99	99	99	99
Arsenic	133	93	93	89	93	93
Asbestos	0.1	0	80	0	0	0
Cadmium	3	34	34	0	34	34
CH_4	5,199	98	98	97	98	98
Carbon monoxide	18,414	0	0	0	0	1
Chromium	1	7	7	1	7	7
Copper	709	93	93	86	93	93
Cl_2	812	0	50	0	0	0
ClO_2	412	0	50	0	0	0
Fluorine	666	98	98	75	98	98
Hydrocarbons	4,603	66	66	52	66	66
Hydrogen chloride	649	75	75	71	75	75
Iron	1,898	93	93	87	93	93
Lead	327	91	91	76	91	91
Mercury	0.4	0	0	0	0	0
Nickel	495	93	93	87	93	93
Nitric acid	678	89	89	0	89	89
NH_3	5,172	90	90	4	90	90
Nitrogen oxides	55,422	24	30	16	24	12
Organic acids	71	99	99	99	99	99
Particulates	114,753	74	77	49	74	60
Perchloroethane	50	100	100	100	100	100
PCB	0.5	49	49	0	49	49
PCDD	0.001	2	2	0	2	2
PCDF	0.002	3	3	2	3	3
ROG	54	98	98	94	98	98
Styrene	1,308	100	100	100	100	100
SO_2	95,894	57	66	18	57	17
Talc	19	0	0	0	0	0
VOCs	108,543	83	85	52	83	23
Zinc	30	93	93	75	93	93

Source: Senes (1988a). DPA (1989)

See DPA (1989) Appendix C for a review of each contaminant.

* Emissions reduction levels from year 2004 only for scenario E.

Several distinct features of the information presented in Table 2-1 and Figure 2-2 should be highlighted. First, the quantity of each contaminant estimated to have been emitted in 1987 can be very large (particulate matter) or very small (PCDD). By and large, there is an inverse relationship between the quantity of a pollutant and its potential toxicological effects. Abatement measures are therefore designed to recognize both the absolute volume and relative hazard of each contaminant.

Second, the assumptions underpinning each of the five scenarios seem to affect each contaminant differently. Under scenario B, the most stringent scenario, emissions of more than half the contaminants would be reduced from 1987 levels by over 50%, while others would decline by 90% or more. Similar high reductions are achieved in scenario A for 14 contaminants, but the reductions for the remainder are not significantly less than under scenario B. In contrast, the emission reductions estimated for scenario C are generally well below those in either scenario A or B.

Figure 2-2 shows that the estimated reductions in particulates, sulphur dioxide, VOC's and the sum of all the contaminants will be reduced by 60% or more under scenarios A and B. Scenarios C and E also offer substantial reductions in particulates and other contaminants and the reduction of VOC's in scenario C is around 50%. The estimated reductions in nitrogen oxides range from about 10-30%. It should be noted that these percentage reductions in emissions of sulphur dioxide and nitrogen oxides are in addition to reductions expected under the Countdown Acid Rain program.

Table 2-1 indicates that scenarios A and D offer identical reductions in emissions, even though scenario A allows some contaminants to be controlled at a lower level than in scenario D. The reason for the identical result is that all the contaminants to which the third and lowest level of control applies in scenario A are contained in emission streams that also have contaminants for which higher levels of control are required. In all cases, abatement measures required for the higher levels of control were applied, such that other contaminants that would otherwise have been controlled at a lower level have more stringent controls applied to them.

2.4 Changes in Ambient Concentrations

To estimate changes in ambient concentrations due to reduced emissions as shown in Table 2-1 three preliminary steps were necessary. First, the geographical location of the 3,585 individual stack sources responsible for these emissions had to be identified. Locations were derived from two data bases: the "Made in Ontario" data base of the Ontario Ministry of Industry, Trade and Technology and a list of establishments from Statistics Canada. The locations of the 2,185 industrial establishments are shown in Figure 2-3. Each establishment was located on a 4 km square grid superimposed on a map of Ontario. Figure 2-3 also shows population density by census subdivision, on which the location of the restaurants and dry-cleaners was based and which was used for analyzing the health benefits of reduced emissions.

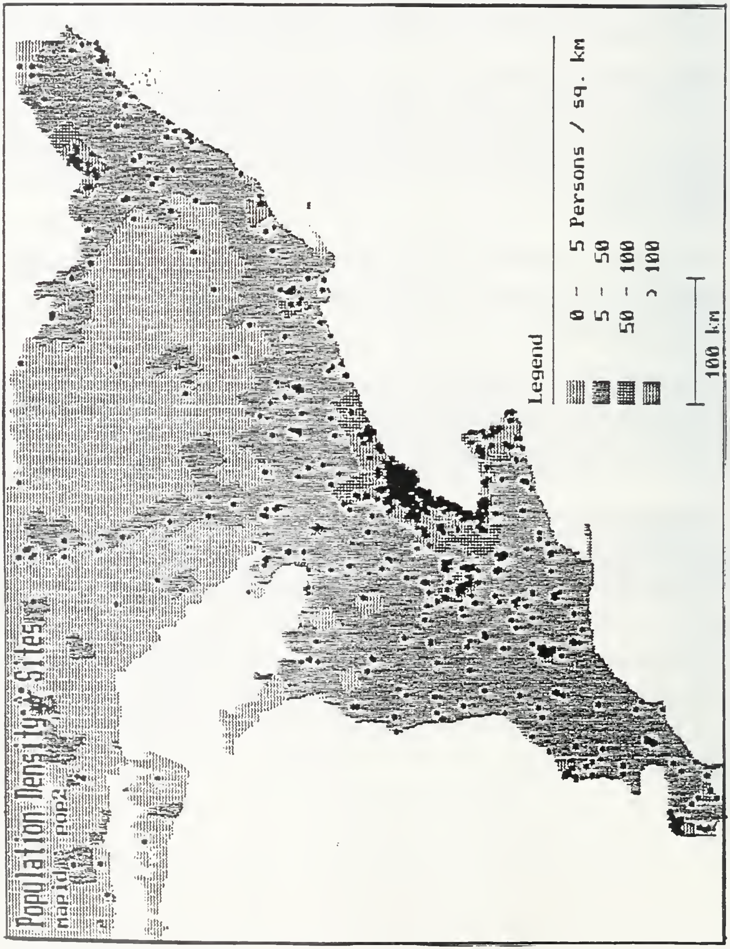
It is apparent from Figure 2-3 that the sources of emissions are concentrated in the more densely populated parts of the Province. This suggests that the principal benefits of reduced emissions will be related to human health.

Two of the categories of contaminants (i.e. particulates and volatile organic compounds) were broken down into more specific contaminants to allow closer application with those of the 44 economic sectors from which they are emitted. Emissions were then allocated to the individual sources.

For the second iteration of the benefit estimation process, the allocation of emissions to stack sources was conditioned by the specific characteristics of the individual sources and contaminants, as derived from a detailed survey sample of stacks undertaken by the Ministry of the Environment.

Figure 2-3

Sources of Contaminants and Location of Population in Ontario



Source: DPA (1989)

The only source of detailed data on the composition of VOC's and particulates is the United States Environmental Protection Agency's (EPA) National Emissions System. This information was used to disaggregate the estimates of emissions of VOC and particulates shown on Table 2-1. It is worth noting that there were no estimated emissions for 39 of the 96 contaminants of interest.

The total emissions estimated for each sector were apportioned to individual sources according to scale, where size is measured by the number of employees. For restaurants, dry-cleaners, poultry processing plants, mobile asphalt paving plants and waste disposal facilities, all sources were assumed to be of equal size.

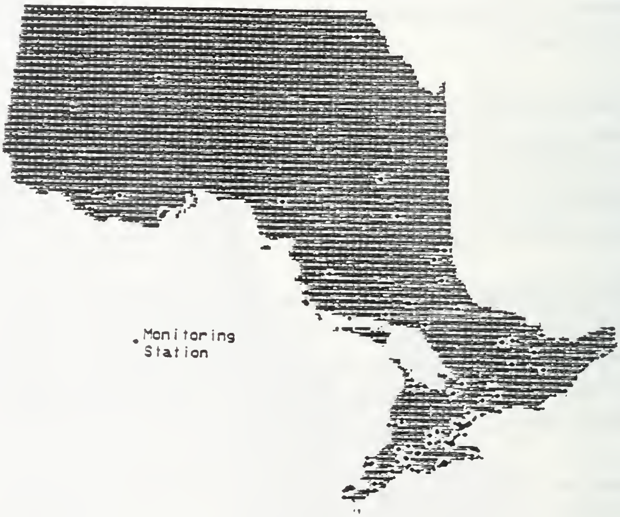
When a contaminant is emitted by a source, it is dispersed over the surrounding area. A dispersion model was used to calculate annual average ambient concentrations attributable to the emissions from each source. The dispersion models that are proposed for inclusion in the revised Regulation 308 cover an area with a radius of 24 km from the source. These were used to calculate 14 dispersion patterns for different parts of the province.

Some of the sources of most of the contaminants listed were not evaluated. Natural sources, for example, can be responsible for substantial quantities of some contaminants. Therefore, to estimate benefits it is sometimes necessary to know the change that is likely to occur in the ambient concentration from all sources, natural and anthropogenic, as a result of the proposed revisions to Regulation 308, which will only affect some sources.

Information on the ambient concentration from all sources is available from the Ministry of Environment's monitoring network (see Figure 2-4). This information is only available for cadmium, lead, manganese, nickel, sulphur dioxide, particulates and VOC's. For these contaminants estimates of ambient concentrations due to other sources were derived by subtracting the estimated ambient concentrations resulting from the estimated emissions affected by Regulation 308 from the monitoring results. It was assumed that these ambient concentrations from other, non-Regulation 308 natural and anthropogenic sources would remain unchanged for all implementation scenarios. Where monitoring information was unavailable, it was not possible to make this adjustment for sources not affected by Regulation 308.

Figure 2-4

Ambient Air Monitoring Stations in Ontario



Source: DPA (1988)

Using the method outlined above, the concentration of each contaminant was estimated at each grid point for each implementation scenario. These concentrations were assumed to apply to the areas immediately surrounding each grid point.

2.5 Population and Resources at Risk

The resources at risk include humans, crops, livestock, forests and surface water. Maps of these resources were converted to a format suitable for use in SPANS (spatial analysis system). SPANS is a geographic information system designed for analyzing and manipulating spatial data; that is, data which relate to points or areas on maps. It was used extensively in the analysis of benefits, and it made possible the use of detailed data on population and resources at risk. Population data by enumeration area were obtained from the 1986 census, agricultural data at the consolidated subdivision level were obtained from the 1986 Census of Agriculture, forestry data were obtained from the National Forestry Service, and surface water data were obtained from the Canada Lands Directorate Service.

For each contaminant and scenario, the changes in the exposure of the resources at risk were estimated by superimposing the estimated changes in ambient concentration on the maps of resources at risk. Three cases can be distinguished:

i) **No Emission Data**

As noted earlier, there were no estimates of emissions for about one third of the contaminants of interest, and so ambient concentrations for these contaminants could not be overlaid on the resources at risk.

ii) **Emissions but No Ambient Data**

In many cases emissions were estimated but there were no monitoring data to provide information about total ambient concentration. Using information on threshold values (levels of concentration at which observable effects occur, generally as indicated by the proposed ambient standards), it was possible to ascertain the extent to which each scenario reduced the population and/or resources exposed to ambient concentrations believed to cause damage. Where current emissions did not exceed the threshold, no further conclusions could be drawn. If the threshold is exceeded by current emission levels, then any reduction in population and/or resources exposed is a benefit.

iii) **Ambient Data Available**

Where the total ambient concentration of contaminants covered by Regulation 308 could be estimated from monitoring data, it was possible to examine changes in total ambient concentrations including both sources affected by Regulation 308 and other unaffected sources. Again, the relevant criterion was the reduction in population and resources exposed to concentrations above the threshold values. Benefits could be identified even when concentrations from regulated sources alone were below threshold levels, providing that the total concentration of contaminants from all sources fell below threshold levels after Regulation 308 was implemented.

2.6 Exposure-Response Relationships

The relationship between the exposure to a contaminant and the consequent damage is called an exposure-response function. Profiles were assembled for each contaminant, summarizing known effects, relevant standards and exposure-response functions where available.

Exposure-response functions were identified for carcinogenic or suspected carcinogenic contaminants. Functions were also available for some non-carcinogenic contaminants which have effects on health: nitrogen dioxide, sulphur dioxide and particulate matter. Functions for visibility effects and damage to materials were available for nitrogen dioxide and particulate matter.

It should be noted that the absence of an exposure-response function does not mean that health or other effects will not occur, only that their magnitude cannot be estimated at present. Furthermore, it should be recognised that the approach taken to benefit estimation, based on measurable benefits within a single year, did not allow for damages resulting from the bio-accumulation of toxic chemicals.

2.7 Overall Economic Evaluation

The economic evaluation of reduction in health risks and environmental damages is usually based on one of two, closely related concepts: the willingness to pay or compensation required by, those affected.

There have been numerous studies in which these economic values have been estimated, though the method is still in an early stage of development. The monetary values used here for health benefits are in use in the United States; they are based on the best available estimates of the value of avoiding death and other health problems. (See Table 2-2.)

The monetary values for death reported in Table 2-2 should be interpreted carefully. They do not refer to the value of any one person's life, but instead to the aggregate value many people place on a small reduction in the risk of premature death. For example, if each of 1 million people is willing to pay $1 for a reduction in the risk of death from 2 deaths per million to 1 death per million, then the total willingness to pay to save one "statistical" life is $1 million. Values of this sort have been estimated from an analysis of wage differentials in occupations associated with greater or lesser risk, using statistical methods to hold other non-risk factors constant. Other studies have arrived at estimates of the value of a statistical life by examining consumer behaviour in the purchase of risk reducing products such as smoke alarms. Finally, there have been studies which ask people for their willingness to pay for small reductions in risk.

Table 2-2: Values Used for Calculating Economic Value of Reduced Change

Type of Damage		1986 U.S. $	1986 C $
Death			
	Central	5,000,000	6,950,000
	Low	1,600,000	2,200,000
Emergency room visits		175	250
Restricted activity days			
	Upper	52	70
	Central	44	60
	Lower	12	15
Hospital days for respiratory conditions		1,050	1,450
Hospital admissions for respiratory disease		6,500	8,580
Damage to Materials		*	*
Visibility		*	*

* represents damages that are not quantified in damage functions on a per event basis.

Conversion rate: 1986 U.S. to 1986 Canadian dollars = 1.39.

Source: DPA (1988)

2.8 Summary of Results

The public benefits expected to result from the proposed revisions to Regulation 308 relate primarily to human health. This is not surprising in that:

- most of the emission sources are located in densely populated areas;
- the contaminants of concern have been identified primarily because they do effect human health; and
- research into the effects of contaminants focuses first on human health, so those are the benefits for which the most information is available. Some of the principal known sources of damage to other environmental resources, such as ozone, nitrogen dioxide and sulphates, play a relatively minor role in this assessment. The largest sources of nitrogen dioxide and sulphate emissions fall under the acid rain initiative and hence outside the purview of this analysis. Ozone was not addressed in this study either, because it is formed in the atmosphere rather than emitted.

2.9 Reduced Mortality

2.9.1 Cancer Mortality

Many of the 96 contaminants analyzed are suspected, probable or known carcinogens. Cancer unit risk factors are available for 20 of those contaminants. These enabled estimates to be made of the reduced risk to cancer mortality resulting from the proposed revisions to Regulation 308, as shown on Table 2-3. A reduction in death due to cancer of ten to seventeen people per year can be expected from reduced exposure to arsenic, chromium and nickel. Reduced exposure to other cancer causing contaminants were found to be insignificant with respect to mortality.

2.9.2 Non-Cancer Mortality

Exposure-response functions for estimating the reduction in non-cancer deaths resulting from lower contaminant emissions are available for sulphur dioxide and particulate matter only. The estimated reductions are shown in Table 2-3.

Table 2-3: Estimated Reduction in Annual Mortality by Contaminant and Scenario

	A & D	B	C	E (to 2003)
Cancer				
1,3 Butadiene	1.0	1.0	1.0	1.0
Arsenic	7.0	8.0	6.0	7.0
Chromium	8.0	8.0	4.0	8.0
Nickel	0.5	0.5		0.5
Subtotal Cancer	17	18	11	17
Non-Cancer				
Sulphur dioxide	56	70	19	19
Particulate matter	11	12	5	8
Subtotal non-cancer	67	82	24	27
Total Reduced Mortality	84	100	35	44
Estimated Value (million 1986 $C)				
low	$184.8	$220.0	$77.0	$96.8
central	$583.8	$695.0	$243.3	$305.8

Source DPA (1988, 1989)

The largest benefit occurs in scenario B, while the smallest benefit occurs under scenario C. Even under scenario C, non-cancer mortality is reduced by 24 lives per year. Under scenario B the annual reduction in non-cancer mortality is 82 lives.

The total reduction in mortality from the proposed revisions to Regulation 308 is estimated to be a total of between 35 and 100 deaths annually. Depending upon the above reduced mortality, this represents yearly public benefits of between $77 million and $700 million, at least 60% of which is from a reduction in non-cancer related mortality.

2.10 Reduced Morbidity

Exposure-response functions for health benefits due to reduced morbidity are available for sulphur dioxide and particulate matter. The estimated human health benefits resulting from reduced emissions of these contaminants are shown in Table 2-4.

The benefits from reduced sulphur dioxide emissions consist of reductions in hospital admissions and the number of hospital days for respiratory conditions. Benefits from reduced particulate matter emissions consist of reductions in emergency room visits and restricted activity days.

Scenario B, the most stringent, yields the greatest benefits, while scenario C, the least stringent, yield the smallest benefits. The benefits resulting from reduced emissions of particulate matter are much greater than those due to reduced sulphur dioxide emissions. This is primarily a reflection of the relative volumes of the two contaminants emitted by the sources analyzed.

In scenario B it is estimated that the annual value of morbidity benefits from reduced concentrations of sulphur dioxide and particulate matter will be between $3 and $13 million. In scenario C these public benefits are estimated between $1 and $5 million.

Table 2-4: Estimated Reduction in Annual Morbidity by Contaminant and Scenario

	A & D	B	C	E
Sulphur Dioxide				
Hospital admissions for respiratory disease	136	171	45	47
Hospital days for respiratory conditions	1,341	1,686	448	460
Value (million 1986 $C)				
low	$0.9	$1.2	$0.3	$0.3
central	$3.1	$3.9	$1.0	$1.1
Particulate Matter				
Emergency room visits	637	681	321	492
Restricted activity days	133,500	142,500	67,000	103,000
Value (million 1986 $C)				
low	$1.4	$1.5	$0.7	$1.1
central	$8.2	$8.7	$4.1	$6.3
Total (million 1986 $C)				
low	$2.3	$2.7	$1.0	$1.4
central	$11.3	$12.6	$5.1	$7.4

Source DPA (1988, 1989)

2.11 Reduced Exposures to Concentrations Above the Proposed Standards

The estimates of human health benefits summarized in Tables 2-3 and 2-4 only capture a part of the human health benefits from more stringent control emissions required to meet the proposed revisions to Regulation 308. Exposure-response functions have yet to be developed for the majority of contaminants examined in this assessment.

In the absence of an exposure-response function, the analysis examined the population exposed to contaminant concentrations above the standard included in the proposed revisions. In the case of cadmium, chromium, lead, nickel and sulphur dioxide, where monitoring information was available, the analysis was based on the estimated ambient concentration (from all sources). For the other contaminants, however, the analysis was limited to exposure to the concentrations estimated from Regulation 308 source emissions alone. In those cases, they underestimate the public benefits of the proposed revisions to Regulation 308.

Table 2-5 summarizes the estimates of population exposed to concentrations of contaminants above the proposed ambient standards. Eleven contaminants were estimated to be at above-standard levels at the estimated emission levels in 1987. The revisions to Regulation 308 under all scenarios will significantly reduce the population exposed to concentration levels above the proposed standards.

The analysis is based on annual average concentrations, the dispersion of these contaminants has been modelled on the assumption that they are gases, and the smallest area considered is 16 km^2. Hence the analysis does not detect concentrations above the proposed standard if they occur in smaller areas, especially near the emission sources, and over shorter periods.

Table 2-5: Estimated Population Exposed to Above-Threshold Concentrations of Contaminants ('000s)

	Current	Scenarios A & D	Scenario B	Scenario C	Scenario E
Arsenic	228	34	34	67	34
Cadmium*	**	-	-	-	-
Chromium*	75	26	26	34	26
Ethylene Dibromide	345	-	-	-	345
Fluorides	**	-	-	-	-
Lead*	12	-	-	-	-
Nickel*	34	-	-	-	-
Nitrogen Oxides	1	1	1	1	1
Silica	645	129	83	288	238
Sulphur Dioxide	67	**	**	12	12
Suspended Particulates	159	22	**	95	45

Notes: * Denotes contaminant for which population exposure is based on ambient concentration from all sources. In all other cases exposure is to concentrations due to Regulation 308 Source emissions alone.

** Population exposed is less than 500.

- Exposure levels are negligible.

Source: DPA (1988)

2.12 Other Public Benefits

2.12.1 Materials Damage

Functions for estimating reduced damage to materials are available for nitrogen oxides and particulate matter. These functions are expressed in terms of the dollar value of materials damage per unit change in ambient concentrations. Consequently, they cannot be used to estimate the reduction in damage measured in physical units, such as the reduced frequency of painting or the increased longevity of materials.

Table 2-6 shows that the estimated benefits from reduced damage to materials are mostly attributable to the reduction in nitrogen oxides. The total value of these benefits ranges from about $240 million per year in the low case under scenario C to over $800 million per year in the central case under scenario B.

2.12.2 Visibility Benefits

As with the reduction in materials damage, the functions available for estimating the value of improved visibility are expressed directly in dollar terms and do not permit benefit estimates to be made in physical units. These functions, which are derived from studies of the value of changes in visibility in California, yield extremely high estimates for the value of improved visibility when applied to the emission reductions considered in this assessment. These high values are due, in part, to the inability of the exposure-response function to distinguish between proportionately large improvements in areas where existing visibility is low, and those where visibility is relatively high. In the latter case, observed visibility increases due to reductions in particulate emissions could be very small, yet would be given the same monetary value as equal percentage reductions in areas where visibility is originally very poor.

Although circumstances do arise in Ontario when impaired visibility due to air pollution is a recognized problem, it is believed that the estimates based on the California situation are not readily transferable to Ontario. For this reason they have been omitted from the main body of this report. They are included, however, in Appendix D.

2.12.3 Odour

Five of the 96 contaminants and emissions from restaurants are considered to be potential odour problems. This assessment indicates that hydrogen sulphide, trichloroethylene and restaurants all satisfy the standards proposed as part of the revisions to Regulation 308.

2.12.4 Phytotoxicity

Only eight of the 96 contaminants are identified as being potentially harmful to plants: cadmium, chlorine, ethylene, hydrogen chloride, nickel, selenium, and sulphur dioxide.

At present only very small areas are exposed to concentrations in excess of the proposed standards for these contaminants. Hence, the public benefits in the form of reduced damage to crops and forests resulting from the proposed revisions are negligible.

Table 2-6: Estimates of Benefits From Reduced Damages to Materials by Scenario (million 1986 $C)

	A&D	B	C	E
Materials Damage				
Nitrogen oxides				
Low	$333.2	$402.9	$234.7	$279.7
Central	$666.3	$805.8	$468.8	$559.4
Particulate matter				
Low	$1	$1	$1	$1
Central	$18	$19	$9	$14
TOTAL				
Low	$334.2	$403.9	$235.7	$280.7
Central	$684.3	$824.8	$477.8	$573.4

Source: DPA (1988), DPA (1989)

2.13 Aggregate Economic Valuation

The estimated value of reduced mortality and morbidity and of less damage to materials resulting from implementation of the proposed revisions are summarized in Table 2-7.

These figures apply only to those few cases where the public benefits can be quantified and the associated economic value can be estimated. The absence of a damage function or even emissions data for a contaminant does not mean that there is no benefit to be had by regulating emissions of that contaminant. Given the limited range of contaminants and benefits that can be quantified and valued, the figures in Table 2-7 should be considered minimum estimates of benefits.

Table 2-7: Aggregate Amount of Benefits to Which an Economic Value Has Been Assigned (Millions of 1986 $C Annually)

	Scenarios A & D	Scenario B	Scenario C	Scenario E
Low Case				
Reduced mortality	$184.8	$220.0	$77.0	$96.8
Reduced morbidity	$2.3	$2.7	$1.0	$1.4
Lower materials damage	$334.2	$403.9	$235.7	$280.7
Total	$521.3	$626.6	$313.7	$378.2
Central Case				
Reduced mortality	$583.8	$695.0	$243.3	$305.8
Reduced morbidity	$11.3	$12.6	$5.1	$7.4
Lower materials damage	$684.3	$824.8	$477.8	$573.4
Total	$1,279.4	$1,532.4	$726.2	$886.6

Source: DPA (1988), DPA (1989)

In the low case, the annual benefits range from $0.3 to $0.6 billion. In the central case, they range from $0.7 to $1.5 billion.

As noted earlier, these estimates show the annual benefits that would have been obtained if the expected reductions in emissions under each scenario had taken place, in full, in 1987. This assumption was made in order to simplify the difficult task of estimating benefits. In fact, the benefits will only be realized as the proposed revisions to Regulation 308 are implemented over time.

Several reasonable adjustments can be made to the estimates of annual benefits shown in Table 2-7 to show the expected annual benefits over the period 1989 to 2005:

i) Annual benefits for all categories other than reductions in cancer-related mortality will be phased in at the same rate as the reduction in emissions under each scenario (see Table 1-1).

ii) To allow for a typical gestation period for cancer, the cancer-related benefits are assumed to be realized 15 years after the reductions in cancer-causing contaminants take place.

iii) With economic growth and the application of the proposed revisions to Regulation 308 to expanded industrial output, the absolute reduction in emissions and related benefits will increase beyond the levels shown in Table 2-7. To account for the effect of economic growth on the benefit estimates, the estimates of annualbenefits derived from i) and ii) are multiplied by the base case projection of the average annual real growth rate of 2.7% for the Ontario economy (Informetrica, 1988).

iv) A second factor that will affect the benefits over time is population growth, because it will increase the number of people and the value of material artifacts that are exposed to contaminants. To account for the effects of population growth on the benefit estimates, the benefits shown in Table 2-7 are multiplied by 1.4% per year, which is the base case projection of the average annual growth rate of the number of households in Ontario (Informetrica, 1988).

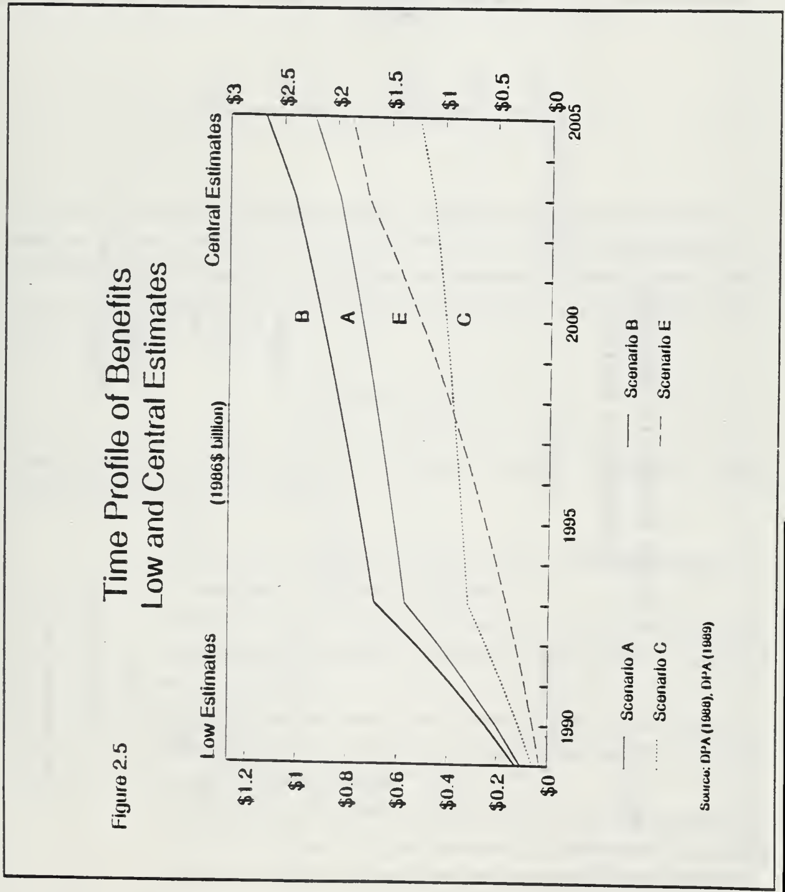
Figure 2-5 shows the time paths of the low and central estimates of total annual benefits based on these adjustments from 1989 to 2005.

Health-related benefits account for approximately 36% of total measured benefits in scenarios A and B if the low estimates of Table 2-7 are used. In scenarios C and E, the percentage is about 25. When the central estimates are examined, these percentages rise to about 46 for scenarios A and B, and about

34 for scenarios C and E. Figure 2-6 illustrates the time paths of the low and central estimates of total and material benefits for scenarios A and E. In this figure, health benefits are the difference between total and material benefits and are clearly seen to be the dominant component.

Figure 2-5

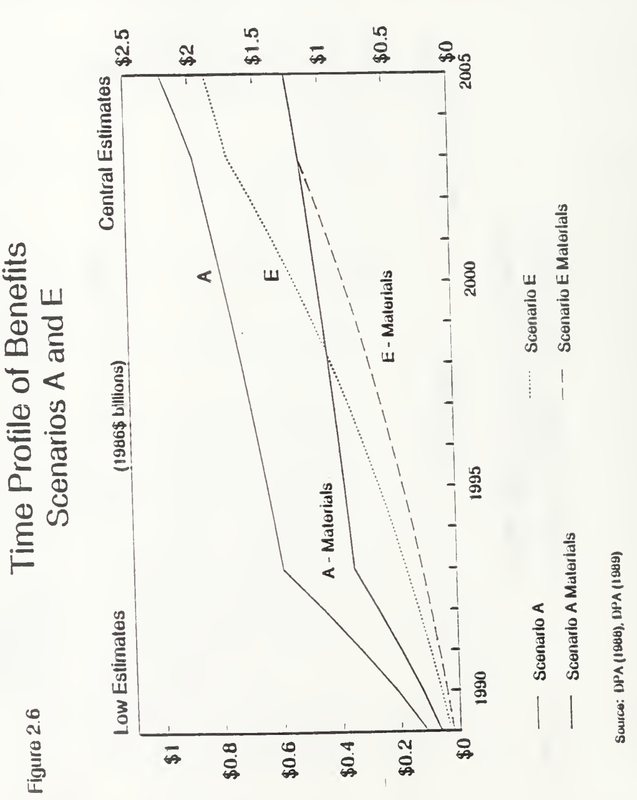
Time Profile of Benefits
Low and Central Estimates



Source: DPA (1988), DPA (1989)

Figure 2-6

Time Profile of Benefits
Scenarios A and E



CHAPTER 3
COSTS

3.1 Introduction

The costs of implementing the proposed revisions to Regulation 308 may be divided into three categories: additional abatement costs, additional monitoring costs and additional administration costs. This chapter explains how these costs were estimated and summarizes the estimates obtained. Chapter 4 considers the implications of these costs for the provincial economy and for the individual sectors and firms that will have to incur them.

3.2 Abatement Costs

A number of tasks were performed in preparing the estimates of additional abatement costs associated with the proposed revisions to Regulation 308:

- Identification of a comprehensive set of air pollution abatement technologies and the contaminants to which they are applicable.
- Identification of removal efficiencies for each general type of technology in terms of ranges of percentage reduction of contaminant release, allowing for variations in stream characteristics.
- From the literature and industry sources, preparation of a reasonable range of capital cost estimates and operating cost estimates for each category of technology, allowing for economies of scale.
- In conjunction with Ministry of the Environment staff, and for the purpose of this assessment, identification of technologies suitable for the three levels of abatement (based on U.S. definitions of LAER, BACT-EA, and NSPS technologies) and the

additional costs of implementing them for each major industrial sector or category of contaminant.

- Selection of a number of representative plants (industrial, waste disposal, and municipal) and, in collaboration with Ministry of the Environment and industry staff, estimation of plant or process specific abatement costs for achieving controls similar to the three levels of abatement.
- Revision of the estimated additional abatement costs in light of plant or process specific costs estimates for each scenario.

The information for the above tasks was obtained from the literature, industrial associations, in-person interviews, telephone inquiries, correspondence with private and public sector representatives, and government reports and files. That information was used to identify particular industries or groups of industries. Although in a few cases data for the complete industry or group were available, more often the data were incomplete. Gaps were filled by scaling up from a known plant's capacity or number of employees. In a few cases, assumptions had to be made about the process and the capacity of an industry because of a lack of data. Altogether, information was gathered for 60 industries (classified at the 4-digit SIC level) and 153 processes drawn from the following sectors:

- Open pit mining
- Food and rendering
- Pulp and paper
- Iron and steel
- Foundries
- Non-ferrous smelters and refineries
- Automotive industry
- Inorganic chemicals
- Petrochemical products
- Asphalt paving
- Power generation
- Waste disposal industry
- Petroleum refineries

Process emission factors were obtained directly or calculated from information in the literature. The amount of annual contaminants emitted was then calculated. In some cases, information on the actual annual amount of contaminants emitted from a specific process or plant was known and emissions factors were generated from these actual emissions. The estimate of emissions and reductions for each scenario shown in Table 2-1 were all based on these emission factors and sector outputs.

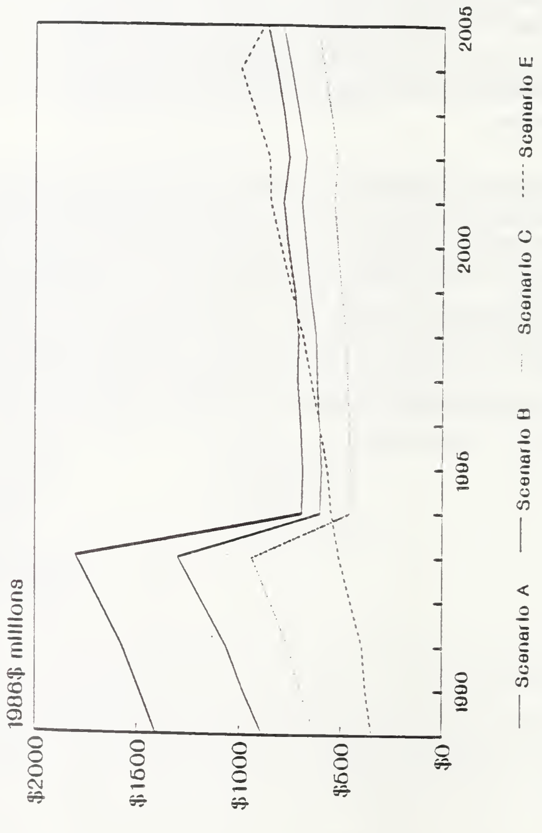
The estimates of the total additional abatement costs in each scenario are shown in Figure 3-1 and the split between capital and operating costs for scenarios A and E is show in Figure 3-2.

The additional annual capital costs for abatement and monitoring in the first year is about $780 million in scenario A, $1,300 million in scenario B and $550 million in scenario C. In the first year of implementation annual capital costs represent 75% of the total annual costs in scenario A, 81% in scenario B and 70% in scenario C. By the end of the five-year implementation period, capital costs for abatement decline to 52% of total annual costs in scenario A, 62% in scenario B and 47% in scenario C. The decline in the percentage of total annual costs attributed to capital costs is due to the increase in operating costs over the five years as more and more plants are brought into compliance with the new regulation.

For scenarios A, B and C in the years following 1993, the additional annual capital costs for abatement decline sharply on the assumption that all existing plants will be in compliance by then. The additional abatement costs estimated for years 1994 through 2005 are for equipping new plants. Increases in productive capacity in each sector requiring approval under the revised regulation were drawn from a base case economic forecast prepared by Informetrica Limited. As a general rule increases in productive capacity grow in line with, or a little more rapidly than, increases in sector output (see section 4.2 below). Scenario E shows a very different time profile of costs. Additional annual capital remain steady at about $300 million per year to 2004. Operating costs rise by about $40 million per year over the same period.

Figure 3-1

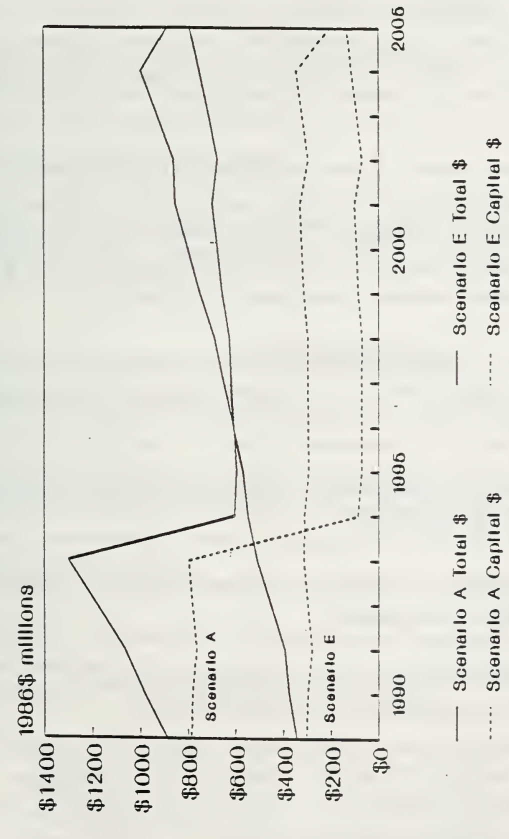
Time Profile of Estimated Costs (Total Costs)



Source. Adapted from Senes (1988a) and Informetrica (1988).

Figure 3-2

Profile of Capital and Operating Costs
(Scenarios A and E)



Source: Adapted from Sense (1988a) and Informetrica (1988).

3.3 Monitoring Costs

Stopping Air Pollution at Its Source calls for "an increased commitment to monitoring stack emissions to provide data for the evaluation of control technologies and to ensure general compliance with the regulatory framework" (p.25). To meet this objective, the Ministry is proposing the following stack-monitoring requirements:

- Level 1 and level 2 sources "will require the installation of continuous monitoring systems (with recording abilities) which reflect process operating conditions and/or maintenance of the emission controls. Stack testing will be required within six months of the facility start-up and subsequently at intervals of not more than twelve months (level 1) and, at the Director's discretion, at intervals of twelve months or more (level 2)."

- Level 3 sources "will require verification of emission rates within six months of start-up by a method acceptable to the Director. Subsequent verification will be at the discretion of the Director."

The Ministry is also proposing that self-monitoring for ambient air quality be increased and included on Certificates of Approval and Control Orders.

In order to estimate the additional costs of monitoring if the proposed revisions to Regulation 308 are implemented, the following tasks were undertaken:

- Identification of a comprehensive set of air pollution monitoring procedures and technologies and the contaminants to which they are applicable.
- Based on experience, literature and industry sources, preparation of a reasonable range of capital and operating cost estimates for the different procedures and technologies.
- In conjunction with Ministry staff, and for the purpose of this assessment, identification of level 1, level 2 and level 3 monitoring requirements and the associated costs of implementation for each industrial sector.

- Selection of a number of representative plants (industrial, waste disposal and municipal) and, in collaboration with Ministry and industry staff, estimation of the monitoring costs required to ensure compliance.
- Preparation of monitoring cost estimates for each scenario.

The costs of operating and maintaining the additional monitoring equipment are much higher in relation to the capital costs than is the case with abatement. In the first year alone, they are equivalent to about 50% of the equipment costs. Indeed, the operating and maintenance costs for monitoring exceed those for abatement in each scenario.

In absolute terms, the total additional annual costs for monitoring in the first year range from about $22 million in scenario C to about $186 million in scenario B. Scenario A is not much less than B at about $165 million in the first year.

3.4 Administration Costs

While most of the costs of complying with Regulation 308 are borne by industrial, municipal and private sector organizations, certain costs for administration are the responsibility of the Ministry of the Environment. The principal administrative change under the proposed revisions will be related to the Certificates of Approval. It is proposed that two-part certificates be issued, one to construct and the other to operate abatement facilities. These certificates will be subject to automatic formal re-examination at ten-year intervals.

For the purpose of this assessment, it was assumed that the additional costs of these Certificates of Approval would only apply to the roughly 3,700 sources likely to be affected by the proposed revisions. The steps required to estimate the additional costs were:

- Identification of Ministry activities currently associated with Regulation 308.
- Examination of the budgets of the branches, sections and units and calculation of the portion of these budgets currently spent on activities associated with the application of Regulation 308.
- Expression of the current costs in unit terms (i.e. per Certificate of Approval).

- Identification and costing of additional tasks to be performed by the Ministry if the revisions are implemented and conversion to unit terms.
- Estimation of the current number of firms assumed to be affected by the proposed revisions to Regulation 308.
- Multiplication of the number of firms by the additional cost per Certificate of Approval, including renewal costs at ten-year intervals.

It should be noted that although this approach to estimating the additional administrative costs is built around the Certificates of Approval, all additional administrative costs are allowed for, regardless of whether they are directly related to the Certificates of Approval. It has been assumed that all other additional administrative costs will vary in direct proportion to the number of approvals.

The estimate of additional costs to the Ministry of the Environment for administering Regulation 308 is based on information provided by the Ministry. This information indicates that in 1987 the average cost of reviewing and approving a Certificate of Approval (without which contaminants cannot be legally emitted into the atmosphere) and all ancillary activities was about $16,000. This cost is expected to rise to about $22,300 under the proposed revisions, at least for the approvals that will be significantly affected by the changes.

The proposed revisions call for all new control orders to incorporate the changes to the regulation. Existing plants will require new Certificates of Approval as they are brought under the revised regulation (i.e. within five years under scenarios A, B, C and D) or sooner if changes are made to existing operations and level 1 controls are required. Furthermore, the proposed revisions require that Certificates of Approval be re-examined every ten years. These rates of implementation and re-examination were used with the higher cost of a Certificate of Approval to estimate the additional administration costs included in Figure 3-1.

In scenarios A, B and C, the additional annual administration costs in the first five years of implementation are about $16 million. After this initial period they decline dramatically to about $0.5 million annually and rise sharply again as the Certificates of Approval start to come up for renewal.

It should be noted that these cost estimates are based on the assumption that only the Certificates of Approval for those firms in sectors identified in this assessment as being most affected by the proposed revisions will impose higher administration costs on the Ministry of the Environment. In all likelihood, this assumption results in the costs being underestimated since the proposed revisions call for all Certificates of Approval to be re-examined at ten-year intervals. Moreover, it is proposed that two-part Certificates of Approval - one to construct and one to operate - be introduced. If applied to all sources, this would significantly add to the additional administration costs reported above.

CHAPTER 4

CONSEQUENCES

4.1 Introduction

The significance of the costs reported in the previous chapter is not easy to interpret. On the one hand these costs indicate the value of resources that must be diverted from other uses in order to obtain the benefits of the revised regulation. These are resources that could be used to produce consumer goods or to build new factories to expand the productive capacity of the economy. Or they could be used to achieve other important social goals in education, health and so on. On the other hand, if the benefits from environmental protection expected from the revised regulation are valued more highly than the costs, it may be concluded that the resources required for compliance would be put to good use.

Any expenditure of large sums, however well justified when considered in aggregate, can be expected to have diverse consequences for the individuals and organizations that make up the economy. These consequences were explored in the economic assessment of the proposed revisions to Regulation 308. The macroeconomic implications were examined with the use of Informetrica's econometric models to estimate possible effects on the provincial economy. Expected changes in gross provincial product, prices, consumer and government expenditures, business investment, employment, disposable income and corporate profits were estimated to the year 2005.

The Informetrica models were also used to examine consequences for individual sectors. Although these sectors are only described at the two-digit SIC level (whereas the costs were estimated for sectors at the four-digit level), the results do show vast differences in the impacts that will be experienced by individual sectors.

To complement this macroeconomic analysis, more detailed consideration was given to those sectors and categories of firms likely to have the greatest financial difficulties in complying with the revised regulation. (See Appendix G).

4.2 Macroeconomic Consequences

The estimates of costs reported in Table 3-1 above represent the additional demands placed upon suppliers of equipment, construction materials and labour needed to comply with the proposed revisions. These values were used to estimate the effect on the national economy, using Informetrica's TIM model. Impacts at the provincial level were modelled using the RIM model, which allocates national effects on industry output and employment by producing sector.

In order to determine the consequences for each sector of having to acquire additional abatement and monitoring equipment, it is necessary to consider how the expenditures would be financed. For the purposes of the macroeconomic analysis it was assumed that all capital expenditures would be financed through working capital, increased equity or increased long-term borrowing, which in general would allow firms to spread costs over many years assuming the financing could be arranged. It was assumed that this additional demand for funds would have no effect on interest rates, and that firms seeking financing can find funds at normal market rates. This assumption is re-examined at the micro level, where the possibility is considered that firms in some sectors might face difficulties.

Before considering the results of the national and provincial model simulations, it is possible to obtain a preliminary indication of the consequences for firms in each major sector that will be directly affected by the revised regulation. Table 4-1 shows current expenditures as a percentage of value added. Current expenses include annual expenses for operating the abatement and monitoring equipment, and the annual cost of servicing the capital expenses required to purchase and install the equipment.

Value added is the difference between the cost of materials and the revenues from sales; i.e. it is the sum of wages, profits and direct, corporate taxes. Table 4-1 shows the

Table 4-1: Estimate of Current Expenses as a Percentage of Value Added of Directly Affected Firms, by Scenario, 2005

	A	B	C
Open pit mines	4.2	4.3	0.3
Food processing	4.2	4.2	2.3
Charcoal-using restaurants	9.6	9.6	0.0
Pulp and paper manufacturing	0.7	0.8	0.5
Pulp and paper, printing and inks	0.9	0.9	0.3
Foundries	4.7	4.7	4.1
Non-ferrous smelters	8.3	8.3	6.1
Iron and steel	3.7	3.7	4.7
Automotive industry	0.9	3.7	0.7
Petroleum refining	50.7	61.3	25.8
Asphalt paving plants	6.4	6.4	6.1
Petrochemicals manufacturing	6.8	6.9	3.9
Dry cleaners	5.4	6.8	2.3
Non-metallic minerals	8.4	8.4	7.4
Electric power	3.2	7.8	0.0

Source: Informetrica (1988)

extent to which firms would have to absorb the additional expenses for pollution abatement through reduced payments to employees, shareholders or the government if they could not pass them on to consumers in the form of higher prices.

Although there is much variation from sector to sector and company to company, on average, profits constitute about 30% of value added. Of this, two-thirds usually goes to pay interest on debt and the balance remains as the return to shareholders. With these rough averages in mind, the percentages shown in Table 4-1 suggest that scenarios A and B could constitute a serious problem for affected firms in all industries, except possibly pulp and paper. They would cause very serious problems (i.e.

additional expenses would exhaust the normal returns to shareholders) for charcoal-using restaurants, non-ferrous smelters and non-metallic mineral producers. Refinery expenses would absorb a significant amount of the income normally provided to labour as well. Scenario C would cause less severe problems for most affected firms, but difficulties would be significant for non-ferrous smelters, the refineries, asphalt producers and non-metallic minerals. By the year 2005 scenario E would be comparable with scenario A.

In this assessment it was assumed that the additional expenses of hospitals and the Ministry of the Environment are covered by increases in provincial direct taxes on households. Additional spending by municipalities is covered by increases in property taxes levied on households and business. Table 4-2 shows how these tax increases vary by scenario.

Table 4-2: Income and Property Tax Increases, Selected Years (in millions of nominal dollars)

	1989	1993	1998	2005
Scenario A				
Income Taxes	27	60	48	71
Property Taxes	5	24	31	42
Scenario B				
Income Taxes	27	60	48	71
Property Taxes	9	42	51	65
Scenario C				
Income Taxes	26	56	42	61
Property Taxes	1	3	4	6
Scenario E				
Income Taxes	10	22	44	91
Property Taxes	2	9	22	45

Source: Informetrica (1988)

4.2.1 Impact on the National Economy

In the previous section, consideration was given to the capacity of firms to absorb the additional costs of complying with the proposed revisions to Regulation 308. Normally, producers can be expected to attempt to pass additional costs on to their buyers. Their ability to do so will vary with the nature of the market and whether all competing producers have similar cost increases. Thus, dry cleaners and electric power producers should have less difficulty since there are no close substitutes for the services they provide. Transport costs for competing suppliers of non-metallic minerals provide some protection for that sector and restaurants may be able to adjust by raising prices or dropping charcoal-cooked food from their menus. For all other producers, close substitutes are likely to constitute significant problems for producers who attempt to pass on the additional costs.

In this assessment, it has been assumed that all producers attempt to pass on the additional costs. The consequences of this on output, investment, employment, wages, profits and prices for the producers are then determined by market demand and price and income elasticities ("market" effects) in foreign and domestic markets.

When firms raise their prices in an attempt to pass on the additional costs of abatement and monitoring, there are also indirect effects which must be considered. For example, higher prices for inks and printing will affect the costs (and prices) of all other firms, including those that are directly affected. Higher commodity prices will induce changes to wages in the economy as a whole as workers attempt to keep pace with rising prices.

To investigate the direct, indirect and induced effects of the proposed revisions at the national level, standard impact procedures were followed. A base case forecast to the year 2005 was prepared by Informetrica using their TIM model, which assesses the national economy in terms of more than 6,000 variables. These include details on approximately 400 items of final demand, including 60 measures of personal consumption, investment expenditures for approximately 60 industry categories, exports and imports for approximately 50 categories of goods and services, and government spending detailed for the federal, provincial and municipal governments as well as spending by school boards and hospitals.

For comparison with the base case forecast, individual scenarios were examined in which assumptions specific to each scenario were introduced to provide alternative forecasts of the economy. Tables E-1 to E-4 in Appendix E, give estimates of the major short- and long-term implications for the national economy for each of the four scenarios.

The real output of the economy should increase initially as a result of the additional demand for abatement and monitoring equipment. In scenario B, the additions to investment could be equivalent to 1% or more of otherwise anticipated capital investment by business, including housing. After another two or three years, when these positive effects on total output dominate, long-lasting negative effects will emerge as firms pass (or attempt to pass) costs on through higher prices. Aggregate prices are expected to rise from the beginning.

The pattern of demand in the economy is expected to shift from personal consumption by households and a diminished foreign trade position towards increased government spending to cover Ministry of the Environment's administration costs and increased spending by municipalities to run waste disposal sites. Reduced consumer demand results from a decline in real disposable incomes of Canadians, which is negligible at first but accelerates throughout the forecast period. A lower foreign trade balance results from higher costs of production in Canada, which are felt from the beginning in each scenario.

The effects on employment are expected to be less than on output, largely because of the increased demand for labour to operate and maintain abatement and monitoring equipment. Labour costs will rise, and profit margins are expected to be largely unaffected after all adjustments are allowed for.

In some industries affected directly (primary metals, petroleum refining and non-metallic minerals), there may be enough additional employment resulting from pollution control to more than offset employment losses resulting from higher costs of production. For all other affected industries, and for most that are not directly affected, reductions in employment are expected.

The initial impact on output is expected to be positive for construction and the manufacture of equipment as a result of additional investment. There should be widespread but somewhat smaller positive effects on other sectors of the economy. After the initial period, increasing negative effects are expected. These will be most pronounced in manufacturing, which is sensitive to diminished private incomes and to competitive pressure in foreign trade. Long term reductions in the output of goods range from 0.4% per year in scenarios C and E to 0.7% in scenario B. The reductions will be greatest for petroleum refining, chemicals, and the iron and steel industry. Smaller negative effects will be felt in the service sector.

4.2.2 Impacts on the Ontario Economy

Provincial impacts were modelled by Informetrica using their RIM model. This model allocates the effects on industry output and employment at the national level to the individual provinces. Effects on producers of goods are determined outside the model as shares of national production. Production of service industries is determined by the performance of goods-producing industries in the province or in bordering provinces. RIM also incorporates an internal migration model, where population movements are determined by employment opportunities. Population, in turn, affects output and employment in each province's service sector.

There are two competing influences which will largely determine the impacts at the provincial level: expenditures for abatement and monitoring equipment will have a positive effect on demand and output in Ontario (where most of the equipment is produced), but directly affected producers in Ontario will attempt to pass on their costs through higher prices and lose some of their market share as a result.

For Ontario, the scenarios suggest an initial increase in total output of between 0.1 percent and 0.35 percent in the first year in scenarios A, B, and C. The positive effect in Scenario E is smaller, reflecting the slower staging-in of investment expenditures made by industries directly by the regulations. These net positive effects are soon eroded by the additional costs to the provincial economy. In scenarios A, B, and C, reduction in total output ranges between 0.25 and 0.34 percent by the completion of the phase-in period and longer term negative effects in the 0.4 to 0.6 percent range. Scenario E yields longer term negative effects of close to 0.5 percent, but these emerge more slowly than in the other three scenarios. (See Appendix F.)

In Ontario, manufacturing will bear most of the negative effects because this sector is most directly affected by the proposed abatement and monitoring program and it is the sector that is most sensitive to a loss of competitiveness and lower consumer incomes.

Employment effects can be expected to follow the same pattern as output, though they will be less severe. In the first two years of implementation it is estimated that annual employment in Ontario will rise by 6,000 to 8,000 under scenario A, 13,000 to 15,000 under scenario B, and 4,000 to 6,000 under scenario C. However, the situation soon changes and, after 10 years the estimated reduction in annual employment will be 16,000 under scenario A, 22,000 under scenario B, and 14,000 under scenario C. The slower rate of implementation of scenario E results in employment increases of 2,000 to 3,000 in the first two years, followed by a reduction in employment of 7,000 after 10 years. Unlike the other scenarios, which show a maximum reduction in employment after 10 years, the reductions in employment continue to increase beyond them under scenario E reaching 9,000 in the year 2005.

It should be noted that, although the impacts are expected to be negative beyond the first year or two, in most cases they are less than 1% and will take up to five years to reach their most severe levels. Thus, it is not suggested that output, incomes and employment will be lower than they are today; rather, that the growth in these measures of economic performance will be somewhat less than they might otherwise be.

Only in the case of primary metals, chemicals and petroleum refining are the impacts so great that an absolute reduction in industry size and employment may result.

4.3 The Impact on the Ontario Environmental Protection Industry of the Proposed Revisions to Regulation 308

Determination of the likely impact of the proposed revisions to Regulation 308 on the Ontario environmental protection industry is complicated by the lack of complete statistics. However, it is possible to state qualitatively how various segments of the industry are likely to fare. Recent studies undertaken by the Ministry of the Environment were intended to define the scope of the environmental protection industry and to measure the actual and potential scale of its operations in Ontario and all of Canada. These studies provide an indication of the segments of the industry that are most likely to benefit from additional demand generated by the proposed revisions to Regulation 308.

4.3.1 Defining the Environmental Protection Industry

Environmental protection includes any activity which has as its major effect the reduction or avoidance of emissions of materials that by virtue of their nature, quantity or quality are, or may become, detrimental to the environment. It also encompasses activities that enable the above activities to take place, such as public consultation on siting issues."

Some of the products and services used for environmental protection activities are highly specialized, but many have a number of general industrial applications. To provide a reasonable idea of the scale of environmental protection activity, the environmental protection industry was defined to include only those products and services for which environmental protection is the dominant application. Although there is some overlap, the industry may be divided into the following sectors: air pollution control, wastewater treatment, solid and hazardous waste disposal and recycling, and instrument manufacturing.

It is estimated that there are some 1200 firms in Ontario that manufacture reasonably specialized environmental protection goods or services. Several hundred additional Ontario firms are essentially distributers of environmental protection goods produced by other firms, including some in Ontario. Direct employment by the Ontario environmental protection industry is estimated to be between 20,000 and 36,000.

Sales of environmental protection equipment, instruments and supplies manufactured in Ontario were roughly $250 to $400 million in 1987. The Ontario recycling industry generated $500 million to $1 billion in sales for 1987, while Ontario waste disposal firms generated $300 to $400 million in revenues. Construction services associated with the installation of environmental protection equipment amounted to about $350 to $500 million in 1987. Consulting, engineering and analytical service firms (commercial laboratories) generated $100 to $200 million in environmental protection revenue in 1987. In total, the environmental protection industry in Ontario had 1987 revenues of $1.5 to $2.5 billion.

During the five years through 1987, sales in the Ontario air pollution control sector grew at an average rate of 21%. This figure may overstate the actual growth of the sector because it captures sales increases tied to the recovery from the recession of the early 1980's.

4.3.2 The Increased Demand for Pollution Control Equipment and Services

The demand for both monitoring and abatement devices will increase significantly as a result of implementation of the proposed revisions to Regulation 308. This is shown clearly in Figures 3-1 and 3-2.

It is estimated that additional expenditures on all abatement and monitoring equipment generated as a result of implementation of the proposed revisions to Regulation 308 will be about $785 million per year in scenario A, $1,300 million per year in scenario B, and $550 million per year in scenario C during the five-year phase-in period. Under scenario E, which is phased in more slowly, additional capital costs are about $300 million per year until the year 2004.

Annual operating costs are also expected to increase steadily by about $100 million per year in scenarios A and B, and $80 million per year in scenario C for the initial five-year period of implementation. Subsequent operating and maintenance costs are expected to increase over time by about $10 million per year in all three scenarios. In scenario E, operating costs increase by about $40 million per year over a much longer period. (All these values are in 1986$.)

4.3.3 Impact on the Environmental Protection Industry

For scenarios A, B, and C the estimated additional expenditures on monitoring and abatement devices during the five-year phase-in period, are equivalent to the current level of environmental protection expenditures for the industry as a whole.

For Ontario firms to satisfy the additional demand for pollution control equipment and services, the Ontario air pollution control sector would, at the very least, have to double in size within one year. It is more likely that a large share of the required equipment would be imported.

To assess the competitiveness of the Ontario air pollution control sector, it must be recognized that multinational companies, based in the U.S., Europe and Japan, appear to be the source of much of the specialized equipment presently in use for air quality control. Canadian-assembled products with some import content appear to make up the majority of items purchased. Ontario content in major capital spending projects is enhanced by the need for on-site metalwork and assembly. Purchasers of air pollution control equipment view Ontario suppliers as specializing in more basic equipment, so that an increase in demand for higher technology devices may increase imports to a greater extent than Ontario sales.

Installation of air pollution control devices involves extensive fabrication of metal. As this activity is currently carried out largely by Ontario firms, it must be determined whether a short phase-in period would create construction bottlenecks.

Implementation of the proposed revisions to Regulation 308 is likely to increase both the number of firms in this sector and the rate of growth in sales above historic rate of 21%. Based on the current size of the air pollution control sector, a five-year phase-in period will require a larger proportion of imported equipment and services than would a longer phase-in period. There would also be greater incentive for long-term growth of this sector if the phase-in period were to last longer than five years.

4.4 Comparison with the United States

The economic implications of the proposed revisions to Regulation 308 discussed in the previous sections were based on the assumption that regulations in other jurisdictions that Ontario competes with are not also changing. If, however, regulations elsewhere are being tightened, the consequences for the national and provincial economies have probably been overstated. Firms in Ontario will not lose their competitive position in domestic and foreign markets if their competitors have similar cost increases for environmental protection.

The situation becomes even more unclear when it is recognized that Regulation 308 is only part of the changing regulatory climate and that the panoply of new and pending regulatory changes in Ontario and other jurisdictions should be considered before conclusions can be drawn about whether Ontario's competitive position is likely to improve or deteriorate over the next 15 to 20 years because of changes in regulation.

Moreover, the competitiveness of the Ontario economy will depend on the success of the Free Trade Agreement with the United States and the next round of GATT multilateral tariff reductions, as well as factors largely or completely beyond the control of government such as technological developments and world prices of raw materials.

It is impossible to weigh all of these considerations to arrive at a reliable prognosis for the Ontario economy, with and without the proposed revisions to Regulation 308. However, just because the economic consequences of revisions to Regulation 308 may be lost in a welter of changes that will occur for other reasons does not make them any less real. The purpose of this economic assessment has been to highlight those specific consequences and to this end, it makes sense to disregard most of the changes which may exacerbate or compensate for the additional costs of pollution abatement in Ontario.

Nevertheless, it remains a valid concern of industry and government whether changes of the sort proposed for Ontario are in line with similar regulations in other jurisdictions with which Ontario firms compete. Although this issue was not addressed comprehensively in this assessment, air pollution regulation in the United States was considered in a preliminary fashion because the U.S. is Ontario's largest foreign trading partner, and the comparison of regulations at the federal and state level is especially important.

Air pollution regulation in the United States has been achieved primarily under the Federal Clean Air Act of 1970, as amended in 1977. This Act sets forth requirements that are enforced by the U.S. Environmental Protection Agency (EPA) and, in some cases, by the individual states. States have also developed their own air pollution control programs, many of which address toxic air pollutants.

The Clean Air Act distinguishes between "criteria pollutants" and "hazardous air pollutants." Criteria pollutants have been subject to comprehensive and broad federal control programs since the early 1970's, but hazardous air pollutants have not been successfully regulated by the federal government.

Criteria pollutants are those for which the EPA is required to establish ambient air quality standards. Such standards have been established for carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone, particulate matter and lead. Each state must submit for EPA approval a State Implementation Plan which details the control measures that will be used to ensure compliance with the federal standards.

To assist in facilitating compliance with ambient standards for criteria pollutants, the Act mandates federal requirements for certain sources. Thus, new major stationary sources of emissions are subject to Federal New Source Performance Standards. In addition, such new stationary sources are subject to Lowest Achievable Emission Rate controls in regions not meeting ambient air quality standards, and Best Available Control Technology controls in regions that are in compliance with ambient standards. These technology decisions are made on a case-by-case basis.

The Act sets up a separate program to regulate hazardous air pollutants. Under section 112, the EPA is required to establish Federal Emission Standards for sources of hazardous air pollutants at a level that provides an ample margin of safety to protect the public health. A hazardous air pollutant is one for which an ambient air quality standard is not available and which may reasonably be expected to result in an increase in mortality, or in serious irreversible, or incapacitating reversible, illness. To date, EPA has prescribed emission limitations for only eight substances: mercury, asbestos, beryllium, vinyl chloride, benzene, radionuclides, inorganic arsenic, and coke oven emissions. A number of these standards were promulgated in the early 1970's and do not reflect currently available technology. Some of the standards consist primarily of workplace practices and monitoring programs, which require little technology, and most of the standards do not cover all of the sources of the pollutants in question.

A recent court decision held that the EPA must not consider costs and technological feasibility in establishing an acceptable level of risk for a pollutant listed as hazardous. These factors can only be considered in establishing an acceptable margin of safety. Thus, the EPA is in the process of developing a new policy on acceptable levels of risk for regulating hazardous air pollutants. Many experts believe that this should result in more stringent control of hazardous air pollutants, but it is not likely to speed up the process of regulation. Thus, there are continuing efforts in Congress to require the act to force more expeditious and comprehensive federal regulation of hazardous air pollutants.

As a result of the EPA's relative inactivity in this area, expenditures for complying with federal hazardous air pollutant requirements has not been a significant proportion of the annual expenditures for air pollution control. The May 1988 Survey of Current Business, published by the U.S. Commerce Department, estimates 1986 annual air pollution control expenditures at just over $33 billion. Since the survey does not distinguish between costs for criteria pollutants and hazardous air pollutants, further research is necessary to determine how much expenditures are devoted to the control of air toxics. A recent study, by the Congressional Research Service, estimates the total costs of proposed amendments to the Clean Air Act (establishing more stringent technology-base controls for air toxics) at about $1 billion annually.

It should also be noted that the EPA's inactivity in the matter of hazardous air pollutants has prompted numerous states to regulate air toxics themselves. About 27 states have air toxic control programs in force, and another 21 have informal or developing programs. These programs are varied in their approaches, some establishing ambient air standards or guidelines for air toxics, others relying on case-by-case risk assessments, and still others prescribing state-wide control technology requirements. Some states regulate existing and new sources, while others only require new sources to meet those requirements. New Jersey, California and Massachusetts are the leaders in establishing these programs. Most of these programs have emerged in the 1980's. As yet, no comprehensive analysis of these programs has been conducted and no estimate of the costs of compliance with these programs has been published.

Finally, the U.S. public's awareness of toxics, in the air and water and on land, will soon be considerably increased by the publication of the toxics release inventory required until Title III of the Superfund Amendment and Reauthorization Act (SARA). Sources of a certain size that manufacture, process or use any of a list of 329 chemicals are required to put this information in a database for review by the public. Both the costs of complying with the reporting requirements and the additional costs of what are likely to be a plethora of new legislation and regulations to reduce toxic releases at the federal, state and local levels, will need to be factored into any long-term analysis of the economic effects of air toxics regulations.

CHAPTER 5

CONCLUSIONS

The previous chapters of this report provided an overview of the methodology used to assess the proposed revisions to Regulation 308 in economic terms. Chapter 2 considered the benefits, Chapter 3 the costs and Chapter 4 the consequences for the national and provincial economies. This concluding chapter begins with some comments on the scope and limitations of the estimates of benefits and costs and then offers a summary comparison of them. The final section of the chapter notes some of the implications of the assessment. No conclusions about the desirability of the proposed revisions to Regulation 308 are offered since many factors not included in this economic assessment would also have to be considered.

5.1 Scope and Limitations of the Estimates of Benefits and Costs

The scope of this assessment is extremely broad, and yet there are several reasons why the results obtained can only be regarded as partial and approximate. Not all sources and types of contaminants likely to be affected by the Regulation were considered, and, for many of the contaminants that were included, exposure-response functions were unavailable. Where exposure-response functions were obtained (from the mainly U.S. literature) they were limited to human health effects, materials damage and visibility associated with individual contaminants. The possibility of synergistic effects among contaminants could not be examined quantitatively. Equally problematic was the question of the bioaccumulation of contaminants, which was also excluded from the quantitative assessment. Finally, the long-range transport of contaminants was excluded from consideration and only those effects predicted to occur within a 24 km radius of the sources were included.

The net result of these omissions on the estimated magnitude and value of the benefits is that they are likely to be significantly below the true values, given the methodologies used. However, it should also be noted that these benefit evaluation methodologies are in a comparatively early stage of development and are most suited to evaluating small-scale, localized environmental impacts. The scope of this assessment is so broad that the values generated should be considered only as a rough indication of what Ontarians are willing to pay for the environmental benefits expected from the proposed revisions to Regulation 308.

There are also limitations on the assessment of the additional costs of abatement, monitoring, auditing and administration though they are less serious than those on the benefits side. Most of the abatement technologies considered in the assessment can be described as "end-of-pipe." It was not possible to estimate the costs of process changes that could achieve the same level of emissions reduction a lower cost. In reality, such changes in production processes, which include using different raw materials and adjustments in product design, can offer more cost-effective means for firms to comply with stricter regulation of emissions, providing they are given enough time to make the changes. It follows that the compliance costs of scenario E may be significantly below those of scenario A merely because firms are given more time to reduce their emissions.

The estimates of the costs of compliance used information from various Canadian and U.S. sources. At all times, efforts were made to produce cost estimates that are realistic and applicable to Ontario. However, there are bound to be firms that will have unusual difficulties in installing additional abatement and monitoring equipment so that the costs developed in the assessment would be too low for them. On the other hand, there are likely to be firms for which the estimates are on the high side. Overall, it would seem reasonable to accept the estimates as plausible, representative costs which, in the aggregate, indicate fairly the costs to industry and government of the proposed revisions to Regulation 308.

Since the revisions would apply to more contaminants and sources than the ones considered, the total compliance costs might be higher than the estimates in this report. At the same time, more comprehensive controls would yield additional benefits, which have also been omitted. The net effect of this limitation on the scope of the assessment cannot be easily determined, but there is no reason to think that it would create a bias in favour of either costs or benefits.

5.2 A Comparison of Benefits and Costs

The estimates of benefits and costs presented in Chapters 2 and 3 can be compared by using standard methods. Table 5-1 shows the total benefits (low and central cases) and costs for each scenario, calculated for 1989-2005 and expressed as an undiscounted total in present value terms at three rates of discount: 5%, 7% and 10%. The table also shows the net benefits for each scenario, calculated as the difference between benefits and costs.

In the low case, net benefits are negative in the range of -\$1.6 billion to -\$4 billion depending on the discount rate and scenario. Net benefits are uniformly positive in the central case, from \$0.7 billion to \$17.86 billion. This variation in the results shows their sensitivity to both components in the benefit calculations: the exposure-response functions and the economic values per unit of impact.

Because of the difference in time paths of the benefits and costs, seen clearly in Figures 3-1 and 2-6, the higher the discount rate the less favourable each of the scenarios becomes. The costs tend to be concentrated in the early years, and the benefits are more evenly spread out through time. Consequently, a higher discount rate has a greater impact on the present value of the benefits than on the present value of the costs.

There are two more considerations that bear on a comparison of benefits and costs. First, the distribution of the benefits and costs among people in Ontario is quite different. Most of the costs will be borne by the shareholders and customers of the companies whose compliance costs rise. The benefits, on the other hand, will be spread more evenly across the population with those people living in the more industrialized regions benefiting the most.

The second consideration is that all the costs estimated in this assessment represent actual payments that companies and government will make in order to comply with the revised regulation. In contrast, only some of the benefits represent reductions in actual cash payments for health care and

for protecting or replacing manufactured materials. This does not mean, however, that the benefit and cost estimates cannot be compared. Indeed, such a comparison does indicate the amount that those who will benefit from cleaner air are willing to pay and what the costs will be to those who must bear

Table 5-1: A Summary of Benefits, Costs and Net Benefits 1989-2005 (1986 $C billion)

	A	B	C	E
BENEFITS				
Low Case	A	B	C	E
Total Benefit	$11.8	$14.1	$7.1	$7.4
Present Value @ 5%	$6.7	$8.1	$4.0	$3.9
Present Value @ 7%	$5.5	$6.7	$3.3	$3.1
Present Value @ 10%	$4.2	$5.1	$2.5	$2.3
Central Case	A	B	C	E
Total Benefit	$29.2	$34.8	$16.7	$18.0
Present Value @ 5%	$16.4	$19.7	$9.2	$9.3
Present Value @ 7%	$13.4	$16.1	$7.5	$7.4
Present Value @ 10%	$10.2	$12.3	$5.7	$5.4
COSTS				
	A	B	C	E
Total Costs	$13.4	$17.0	$10.0	$11.2
Present Value at 5%	$9.2	$12.0	$6.8	$6.9
Present Value at 7%	$8.1	$10.7	$6.0	$5.8
Present Value at 10%	$6.8	$9.1	$5.0	$4.6
NET BENEFITS				
Low Case	A	B	C	E
Total	-$1.6	-$2.9	-$2.9	-$3.8
Present Value at 5%	-$2.5	-$3.9	-$2.8	-$3.0
Present Value at 7%	-$2.6	-$4.0	-$2.7	-$2.7
Present Value at 10%	-$2.6	-$4.0	-$2.5	-$2.3
Central Case	A	B	C	E
Total	$15.8	$17.8	$6.7	$6.8
Present Value at 5%	$7.2	$7.7	$2.4	$2.4
Present Value at 7%	$5.3	$5.4	$1.5	$1.6
Present Value at 10%	$3.4	$3.2	$0.7	$0.8

them. It is because the market system cannot respond properly to the willingness of people to pay for cleaner air that the government is called on to intervene on their behalf.

Nevertheless, it is of some interest to consider what proportion of the estimated benefits correspond to actual reductions in expenditures if the revisions to Regulation 308 are implemented. As an approximation, in the low case 15% of the mortality benefits, 50% of the morbidity benefits and 100% of the materials damage benefits will show up as reductions in out-of-pocket expenses. Using these percentages, the benefits that will be reflected in expenditure reductions represent between 52% and 78% of the costs, depending on the scenario and discount rate.

5.3 Some Implications for Implementation

As noted in Chapter 1, the actual implementation of the proposed revisions to Regulation 308 will doubtless be different from any of the scenarios examined in this assessment. However, it is clear from Table 5-1 that the stringency of the standards and the timing of their implementation can make a very substantial difference to the net benefits. Consider the following observations based on Table 5-1:

- A comparison of the net benefits of scenario A and the less stringent scenario C in either case suggests that it is important to implement the proposed revisions quite stringently in order to ensure that the benefits exceed the costs (in the central case) or that negative net benefits are minimized (in the low case).
- A comparison of the net benefits of scenario A with those of the more stringent scenario B suggests that an increase in stringency may eventually add more to compliance costs than to the measurable benefits.
- Scenario E is identical to scenario A except that the revised regulation is implemented more slowly under E. A comparison of the net benefits for these scenarios suggests that a significant proportion of the net benefits achieved under scenario A will not be realized at the slower rate of implementation of scenario E.

In addition to these observations based upon Table 5-1, two other observations regarding implementation should be noted:

- The proposal to implement more stringent standards over several years may give some firms a competitive advantage. This problem can be minimized by implementing the revised regulation sector by sector. However, firms classified in different industrial sectors still compete with each other for skilled labour and capital, and they may also compete in the same product markets when the primary product of one sector is a secondary product for another. The problems posed by upsetting competitive forces is most acute when new firms are immediately subjected to more stringent regulations but existing firms with which they are in direct competition are temporarily exempt.

- Although, in the central case, the expected benefits appear to be significantly greater than the costs, the costs are substantial, especially for some sectors, such as primary metals, non-metallic minerals, chemicals and refineries. Rather than delay implementation to mitigate the impact on firms in these sectors, some consideration should be given to means by which the costs of compliance can be spread more broadly across industries and, possibly, the taxpayers at large. While it is important not to compromise the "polluter-pays" principle without good reason, it would be unfortunate if the very large benefits offered to many Ontarians by this change in regulation were not realized because of the adverse impact on a relatively small number of firms.

Of course, all of these tentative conclusions should be qualified by a consideration of the assumptions underlying the economic assessment, as discussed in Chapter 1.

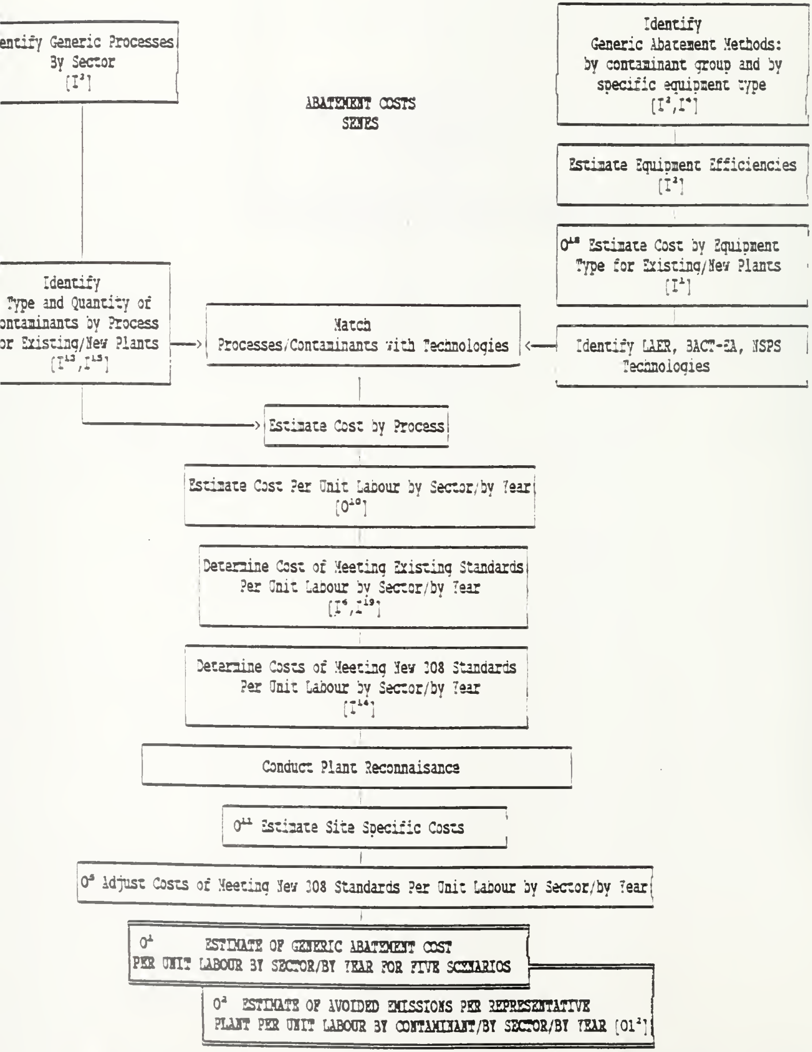
THE ECONOMIC ASSESSMENT REPORTS

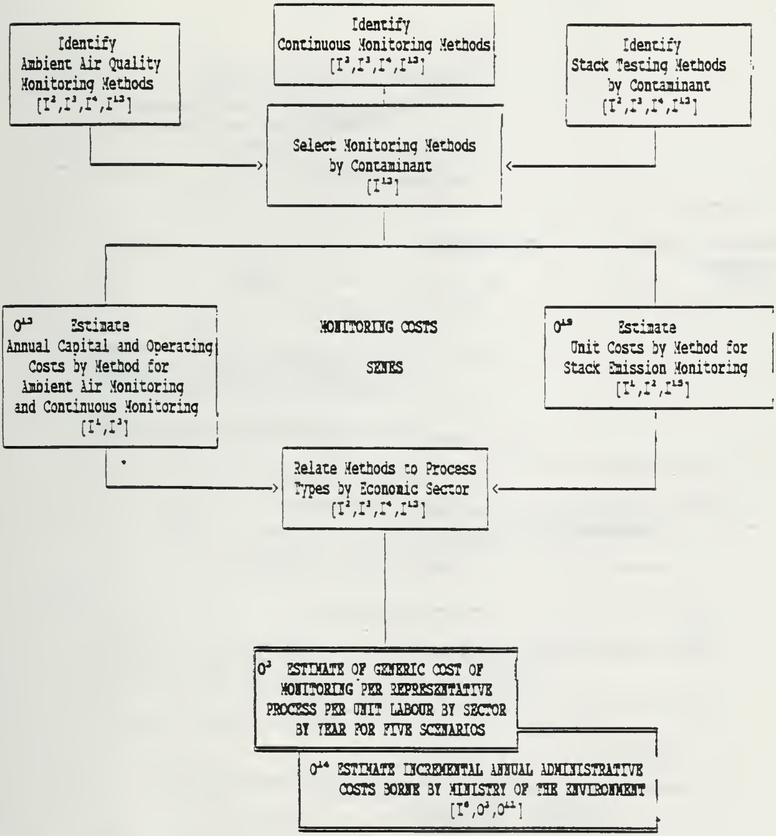
This report is a synthesis of the following reports which were prepared for the Ontario Ministry of the Environment:

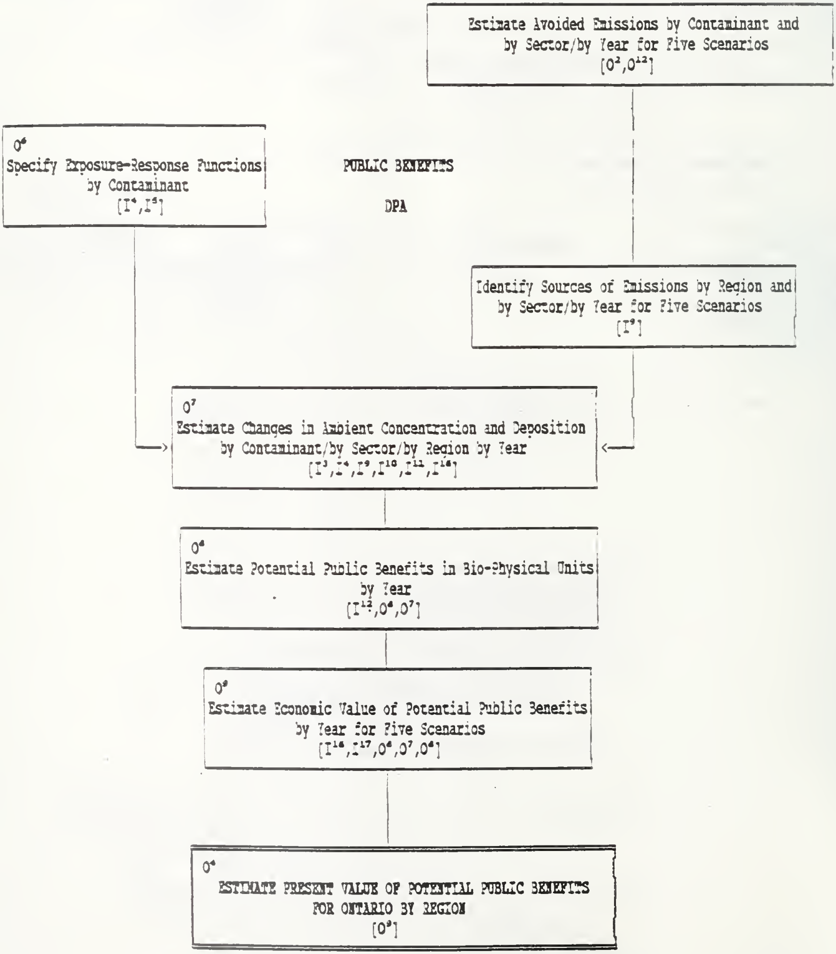
DPA (1988)	Estimated Public Benefits of Implementing the Proposed Revisions to Regulation 308 Volumes I - IV, The DPA Group Inc., September, 1988 Draft
Senes (1988a)	Estimation of Addition Abatement Costs for the Proposed Revisions to Regulation 308, SENES Consultants Limited, August, 1988 Draft
Senes (1988b)	Monitoring, Auditing and Administration Costs for Revisions to Regulation 308, SENES Consultants Limited, August, 1988 Draft
Informetrica (1988)	Ontario Aggregate and Sectoral "Macroeconomic" Impacts of Revisions to Regulation 308, Informetrica Limited, September 12, 1988 Draft
Hickling (1988)	Estimation of the Economic Costs and Consequences of Implementing the Proposed Revision to Regulation 308, Hickling Management Consultants, September 13, 1988 Final Draft
DPA (1989)	Impact of Dispersion Assumptions on the Estimated Benefits of Reducing S02 and Particulate Matter Emissions. The DPA Group Inc. and Monenco Consultants Ltd., July 1989.

APPENDIX A

LOGIC DIAGRAM OF STUDY COMPONENTS

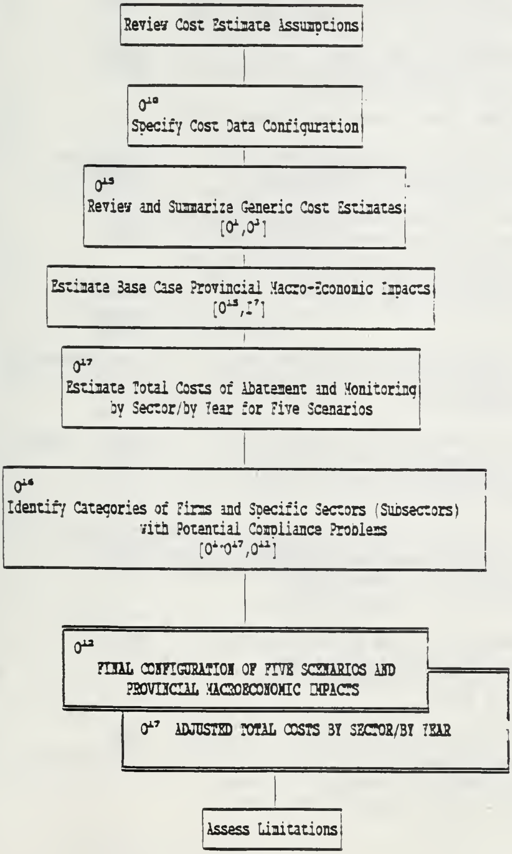

ABATEMENT COSTS
SERIES
entify Generic Processes
By Sector
[I^2]
Identify
Generic Abatement Methods:
by contaminant group and by
specific equipment type
[I^3,I^4]
Estimate Equipment Efficiencies
[I^2]
0^{18} Estimate Cost by Equipment
Type for Existing/New Plants
[I^1]
Identify
Type and Quantity of
ontaminants by Process
or Existing/New Plants
[I^{13},I^{15}]
Match
Processes/Contaminants with Technologies
Identify LAER, BACT-EA, NSPS
Technologies
Estimate Cost by Process
Estimate Cost Per Unit Labour by Sector/by Year
[0^{10}]
Determine Cost of Meeting Existing Standards
Per Unit Labour by Sector/by Year
[I^6,I^{19}]
Determine Costs of Meeting New 308 Standards
Per Unit Labour by Sector/by Year
[I^{14}]
Conduct Plant Reconnaisance
0^{11} Estimate Site Specific Costs
0^5 Adjust Costs of Meeting New 308 Standards Per Unit Labour by Sector/by Year
0^1 ESTIMATE OF GENERIC ABATEMENT COST
PER UNIT LABOUR BY SECTOR/BY YEAR FOR FIVE SCENARIOS
0^2 ESTIMATE OF AVOIDED EMISSIONS PER REPRESENTATIVE
PLANT PER UNIT LABOUR BY CONTAMINANT/BY SECTOR/BY YEAR [01^2]


Identify Ambient Air Quality Monitoring Methods $[I^2,I^3,I^4,I^{13}]$
Identify Continuous Monitoring Methods $[I^2,I^3,I^4,I^{13}]$
Identify Stack Testing Methods by Contaminant $[I^2,I^3,I^4,I^{13}]$
Select Monitoring Methods by Contaminant $[I^{13}]$
O^{13} Estimate Annual Capital and Operating Costs by Method for Ambient Air Monitoring and Continuous Monitoring $[I^1,I^2]$
MONITORING COSTS
SERIES
O^{15} Estimate Unit Costs by Method for Stack Emission Monitoring $[I^1,I^2,I^{15}]$
Relate Methods to Process Types by Economic Sector $[I^2,I^3,I^4,I^{13}]$
O^3 ESTIMATE OF GENERIC COST OF MONITORING PER REPRESENTATIVE PROCESS PER UNIT LABOUR BY SECTOR BY YEAR FOR FIVE SCENARIOS
O^{14} ESTIMATE INCREMENTAL ANNUAL ADMINISTRATIVE COSTS BORNE BY MINISTRY OF THE ENVIRONMENT $[I^6,O^3,O^{11}]$


PUBLIC BENEFITS
DPA
Estimate Avoided Emissions by Contaminant and by Sector/by Year for Five Scenarios
$[O^2, O^{12}]$
O^6
Specify Exposure-Response Functions by Contaminant
$[I^4, I^5]$
Identify Sources of Emissions by Region and by Sector/by Year for Five Scenarios
$[I^9]$
O^7
Estimate Changes in Ambient Concentration and Deposition by Contaminant/by Sector/by Region by Year
$[I^3, I^4, I^9, I^{10}, I^{11}, I^{16}]$
O^8
Estimate Potential Public Benefits in Bio-Physical Units by Year
$[I^{12}, O^6, O^7]$
O^9
Estimate Economic Value of Potential Public Benefits by Year for Five Scenarios
$[I^{16}, I^{17}, O^6, O^7, O^8]$
O^4
ESTIMATE PRESENT VALUE OF POTENTIAL PUBLIC BENEFITS FOR ONTARIO BY REGION
$[O^9]$

MACROECONOMIC COSTS AND CONSEQUENCES

INFORMETRICA


Review Cost Estimate Assumptions
0^{10}
Specify Cost Data Configuration
0^{15}
Review and Summarize Generic Cost Estimates
$[0^1, 0^3]$
Estimate Base Case Provincial Macro-Economic Impacts
$[0^{15}, I^7]$
0^{17}
Estimate Total Costs of Abatement and Monitoring by Sector/by Year for Five Scenarios
0^{16}
Identify Categories of Firms and Specific Sectors (Subsectors) with Potential Compliance Problems
$[0^1 \cdot 0^{17}, 0^{11}]$
0^{12}
FINAL CONFIGURATION OF FIVE SCENARIOS AND PROVINCIAL MACROECONOMIC IMPACTS
0^{17} ADJUSTED TOTAL COSTS BY SECTOR/BY YEAR
Assess Limitations

Exogenously Obtained Analytical Inputs

		Produced by:	Used by
1.	Equipment Supplier Prices (converted to Cdn. funds and deflated to $1986)	SENES	SENES
2.	Equipment Specifications as Provided by Equipment Manufacturers/Suppliers	SENES	SENES
3.	List of Relevent Economic Sectors/Activities by 1980 SC Code as Suggested by SENES and DPA in Consultation with Steering Committee	SENES DPA	SENES
4.	List of Selected Contaminants provided by Steering Committee	STEERING COMMITTEE	SENES
5.	Information on Toxicological Effects of Selected Contaminants Obtained from MoE Dossiers, MoE MISA Files and U.S. source material	MOE DPA	DPA
6.	O.Reg. 308	SENES	SENES
7.	Projected Real Rate of Growth by Sector (in the absence of revisions to Regulation 308)	INFORMETRICA	INFORMET
8.	Estimate of Resources Required to Administer Adequately Air Quality Monitoring Programmes and Ensure Compliance	SENES (MOE)	SENES
9.	Regional Distribution of Economic Activity by SC Code as Derived by DPA from MOE Lists of Contaminant Generators by SC Code/Location	DPA (MOE)	DPA
10.	Maps Relevant to the Modelling of Meteorological Conditions and Desposition of Contaminants as Provided by DPA	DPA	DPA
11.	Meteorological Information on Ontario Regions as Mapped by 10 as is Available from Environment Canada, Atmospheric Environment Service	DPA (Wx RESEARCH)	DPA

		Produced by:	Used by:
12.	Inventories of Buildings and Structures, Land Use Characteristics, Population, etc., as obtainable from MOE, Statistics Canada	DPA	DPA
13.	Information on emissions by process type from Certificate of Approval data as supplied by MOE and garnered from the Engineering Literature	SENES	SENES
14.	Green Paper	SENES	SENES
15.	Assumed Level of Output (specified in physical output terms or value of physical output terms) and Capacity Utilization Factor by Sector for generic process/plant	SENES	SENES
16.	Unit Values and market value adjustments for non-traded goods as deemed applicable from survey of benefit-cost literature	DPA	DPA
17.	Discount rate(s) as set in consultation with the Ministry of Treasury and Economics	VHB DPA	DPA
18.	Atmospheric Dispersion Model associated with Revised Regulation 308	MOE Wx RESEARCH	DPA
19.	Information from Industry Associations and Specific Representative Companies	SENES	SENES HICKLI

	Endogenously Obtained Analytical Outputs	Produced by	Used by
1.	Estimate of Generic Abatement Cost by Sector/by Year	SENES	INFORMETR
2.	Estimate of Avoided Emissions by Contaminant/by Sector/by Year	SENES	DPA
3.	Estimate of Generic Cost of Monitoring by Sector/by Year	SENES	INFORMETR
4.	Estimate of Present Value of Potential Public Benefits for Ontario by Region	DPA	
5.	Adjustments to Indicated Costs and/or Emissions by Sector Provided According to Data Gathered by SENES on Site Visits	SENES	SENES
6.	Exposure-Response Functions Linking Contaminants to Effects on Health, Flora, Fauna, Structures, etc.	DPA	DPA
7.	Estimate of Changes in the Quantity of Contaminants Deposited by Contaminant/by Region	DPA	DPA
8.	Estimate of Potential Public Benefits Measured in Bio-Physical Units	DPA	
9.	Estimate of Economic Value of Potential Public Benefits by Year by Region	DPA	
10.	Specification of Cost Data Configuration	INFORMETRICA	SENES
11.	Estimate of Site Specific Costs to be Used for Adjustment of Generic Estimates by Sector	SENES	INFORMET
12.	Projected Annual Real Rates of Growth by Sector Adjusted for Changes in Output Prices Due to Increased Unit Cost Related to Abatement and Monitoring	INFORMETRICA	INFORMET
13.	Estimate of Ambient Air Monitoring Capital and Operating Costs by Method	SENES	SENES

14.	Estimate of Incremental Annual Administrative Costs Borne by MOE	MOE (SENES)	SENES
15.	Summary of Generic Cost Estimates	INFORMETRICA	INFORMET
16.	List of Firms/Plants/Sectors with Potential Compliance Problems	INFORMETRICA HICKLING	
17.	Total Cost by Sector/by Year of Proposed Revisions to Regulation 308	INFORMETRICA	
18.	Estimates of Cost by Equipment Type for Existing and New Plants	SENES	SENES
19.	Estimate of Capital Costs by Method for Stack Emission Monitoring	SENES	SENES

APPENDIX B

LIST OF REGULATION 308 CONTAMINANTS
REFERRED TO IN STUDY

Acrylonitrile
Ammonia
Arsenic
Arsine
Asbestos (Fibers of length greater than 5 micrometers)
Asbestos (Total)
Benzene
Benzo(a)pyrene
Beryllium
2-Butanone (Methyl Ethyl Ketone)
Butyl Acrylate
Cadmium
Calcium Cyanide (As total salt)
Captan
Carbon Tetrachloride
Chlordane
Chlorinated Dibenzo Dioxins (CDDs)
Mixtures of Chlorinated Dibenzo Dioxins
 and Chlorinated Dibenzo Furans (CDFs)
Chlorine
Chlorine Dioxide
Chloroform
Chromium
Coal Tar Pitch Volatiles (Soluble fraction)
Chromium (Di, Tri, and Hexavalent forms)
Epichlorohydrin
Ethyl Benzene
Ethylene
Ethylene Dibromide
Ethylene Dichloride
Ethylene Glycol Butyl Ether (Butyl Cellosolve)
Ethylene Glycol Butyl Ether Acetate (Butyl Cellosolve Acetate)
Ethylene Glycol Ethyl Ether (Cellosolve)
Ethylene Gylcol Ethyl Ether Acetate (Cellosolve Acetate)
Ethylene Oxide
Fluorides
Formaldehyde
Hexachlorocyclopentadiene
Hydrogen Chloride
Hydrogen Cyanide
Hydrogen Sulphide
Inhalalable Particulates (Less than 10 micrograms)
Lead
Manganese Compounds
Mercaptans
Mercury
Mercury (Alkyl)
Methane Diphenyl Diisocyanate

Methyl Isobutyl Ketone
Methylene Chloride
4,4-Methylene-bis-2-chlorol-aniline
Naphthalene
Nickel
Nickel Carbonyl
Nitrogen Oxides
Nitrous Oxide
Ozone
Pentachlorobenzenes
Pentachlorophenol
Perchloroethylene
Phenol
Phosgene
Phosphene
Polychlorinated Biphenyls (PCB's)
Polycyclic Aromatic Hydrocarbons (PAH's)
Potassium Cyanide (As total salt)
Potassium Hydroxide
Propionaldehyde
Propionic Acid
Propylene Glycol Methyl Ether
Propylene Glycol Monomethyl Ether Acetate
Propylene Oxide
Selenium
Silica-respirable (Less than 10 micrometres in diameter)
Sodium Cyanide (As total salt)
Sodium Hydroxide
Styrene
Sulphur Dioxide
Sulphuric Acid
Suspended Particulate Matter (Less than 44 microns in size)
Tetrachlorobenzenes
Tetrachlorophenols
Thiourea
Tin
Toluene
Toluene Diisocyanate
Total Reduced Sulphur (TRS)
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane (Methyl Chloroform)
Trichlorobenzenes
Trichloroethylene
Tricholorophenols
Vinyl Chloride
Xylenes
1,3 Butadiene*
Polycyclic organic matter*
Trichromium*

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* Added during the course of the study

APPENDIX C

LIST OF SECTORS COVERED

Mining Industries	Plants	Employees
0611 Gold Mines (only pit only)	4	1210
0617 Iron Mines (open pit only)	2	700
Food Industries		
1011 Meat and Meat Products Industry	114	8077
1012 Poultry Products Industry	32	
1021 Fish Products Industry	17	551
1049 Other Dairy Products Industries (Whey drying only)	7	1117
Paper and Allied Products Industries		
2711 Pulp Industry	9	7209
2712 Newsprint Industry	11	6139
2713 Paperboard Industry	16	2737
Printing, Publishing and Allied Industries		
2811 Business Forms Printing Industry	44	4228
2819 Other Commercial Printing Industries	356	23601
2821 Platemaking, Typesetting and Bindery Industry	129	6133
2841 Newspaper, Magazine and Periodical (Combined Publishing and Printing) Industry	81	12205
2849 Other Combined Publishing and Printing Industries	11	528
Iron and Steel Industries		
2911 Ferro-Alloys Industry	1	16
2912 Steel Foundries	22	39009
2919 Other Primary Steel Industries	35	2205
Foundries		
2941 Iron Foundries	61	7110
2959 Other Primary Smelting and Refining of Non-Ferrous Metal Industries	15	7761
2971 Copper and Copper Alloy Rolling, Casting and Extruding Industry	23	2149
2999 Other Rolled, Cast and Extruded Non-Ferrous Metal Products Industries	63	5623

Automobile and Automotive Parts

3231 Motor Vehicle and Parts Industries (Painting activities only)	212	125769
3254 Motor Vehicle Steering and Suspension Parts Industry	32	7106
3255 Motor Vehicle Wheel and Brake Industry (Brake lining & aluminum wheel plants only)	6	1570
3259 Other Motor Vehicle Accessories, Parts and Assemblies Industries (Batteries only)	5	548

Non-Metallic Mineral Products Industries

3511 Clay Products Industry (From Domestic Clay)	26	1405
3512 Clay Products Industry (From Imported Clay)	51	1137
3521 Hydraulic Cement Industry	8	2092
3571 Abrasives Industry	25	1906
3581 Lime Industry	9	885

Refined Petroleum Products Industries

3611 Refined Petroleum Products Industry	7	3810

Asphalt Paving Plants

3699 Other Petroleum and Coal Products Industries (Portable asphalt paving plants)	24	

Inorganic Chemical Products Industries

3711 Industrial Inorganic Chemical Industries n.e.c.	67	790

Organic Chemical Products Industries

3712 Industrial Organic Chemical Industries n.e.c.	37	7114
3721 Chemical Fertilizer and Fertilizer Materials Industry	13	1279
3731 Plastic and Synthetic Resin Industry	80	5539
3751 Paint and Varnish Industry	98	6185
3791 Printing Ink Industry	40	1693
3792 Adhesives Industry	43	1469
3799 Other Chemical Products Industries n.e.c.	138	9891

Electric Power Generation

4911 Electric Power Systems Industry (Fossil fuel fired stations only)	6	

Waste Disposal

4999 Municipal Landfills	47
4999 Municipal and Commercial Incinerators	3
4999 Sewage Sludge Incinerators	5
4999 Hospital Incinerators	100

Restaurants

9211-9213 Restaurants, (Charcoal barbecue restaurants only)	200

Dry Cleaners

9721 Power Laundries and/or Dry Cleaners	1200

APPENDIX D

ESTIMATES OF BENEFITS FROM IMPROVED VISIBILITY BY SCENARIO

(MILLION 1986 $C)

Table D-1: Estimated Benefits From Improved Visibility by Scenario (Million 1986 $C)

	A	B	C	E
Nitrogen Oxides				
Low	$1,249.0	$1,361.4	$932.5	$1,013.2
Central	$2,560.4	$2,790.9	$1,911.6	$2,077.0
Particulate Matter				
Low	$653.2	$700.2	$328.4	$583.4
Central	$1,306.3	$1,400.3	$656.7	$1,166.8
Total				
Low	$1,902.2	$2,061.6	$1,260.9	$1,596.6
Central	$3,866.7	$4,191.2	$2,568.3	$3,243.8

Source: DPA (1988)

Table D-1: Estimated Benefits From Improved Visibility by Scenario (Million 1986 $C)

Nitrogen Oxides				
Low	$1,249.0	$1,361.4	$932.5	$1,013.2
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Central	$1,306.3	$1,400.3	$656.7	$1,166.8
Total				
Low	$1,902.2	$2,061.6	$1,260.9	$1,596.6
Central	$3,866.7	$4,191.2	$2,568.3	$3,243.8

Source: DPA (1988)

APPENDIX E

SUMMARY OF NATIONAL ECONOMIC IMPACTS

Table E.1

NATIONAL ECONOMIC IMPACT OF SCENARIO A

Scenario A, Sep 6		1989	1990	1993	1998	2005
				% Impact		
*** Gross National Expenditure ***						
Value		0.15	0.10	0.20	0.30	0.37
Price		0.01	0.03	0.28	0.51	0.53
Volume		0.13	0.07	-0.07	-0.20	-0.16
*** Volumes ***						
Consumption Expenditure		0.02	0.01	-0.08	-0.12	-0.04
Durables		0.04	0.01	-0.12	-0.13	-0.01
Other		0.02	0.01	-0.07	-0.12	-0.05
Government Expenditure		0.12	0.12	0.20	0.22	0.50
Current		0.06	0.06	0.16	0.26	0.59
Capital		0.51	0.46	0.41	0.03	0.09
Business Investment		0.69	0.74	0.52	-0.10	0.03
Residential		0.02	0.04	0.06	-0.08	-0.01
Nonresidential		0.91	0.98	0.66	-0.11	0.03
Inventory Change	(a)	78	-15	-46	10	3
Net Exports	(a)	-142	-163	-268	-326	-568
Exports		-0.03	-0.05	-0.14	-0.21	-0.23
Merchandise		-0.03	-0.05	-0.14	-0.23	-0.25
Services		0.00	-0.02	-0.09	-0.12	-0.09
Imports		-0.25	0.27	0.33	0.29	0.51
Merchandise		0.27	0.27	0.29	0.19	0.29
Services		0.18	0.26	0.44	0.57	1.25
*** Labour Market ***						
Labour Force		0.01	0.00	-0.01	0.01	0.03
Employment		0.09	0.09	0.02	-0.10	0.00
Unemployment		-0.93	-0.93	-0.41	1.23	0.52
Unemployment Rate (%)	(a)	-0.08	-0.08	-0.03	0.10	0.03
*** Wages and Prices ***						
Wage & Salary/Employee ($C)		0.03	-0.01	0.14	0.41	0.43
Output per Employee ($71)		0.04	-0.01	-0.09	-0.08	-0.11
Priv. Non-Agr Unit Lab. Cost		-0.02	-0.01	0.22	0.46	0.45
Impl. Deflator of Imports		0.01	0.01	-0.02	-0.02	-0.02
Implicit Output Deflator		0.02	0.04	0.29	0.52	0.55
Consumer Price Index		0.01	0.02	0.20	0.39	0.39
*** Incomes ***						
Disposable Income/Capita		0.03	0.02	-0.09	-0.11	-0.02
Corporate Profits		0.23	0.06	0.09	0.41	0.42
Government Balances (Mn $C)						
All-Governments	(a)	317	125	-122	-891	-2372
Federal	(a)	309	141	239	85	630
Non-Federal	(a)	16	0	-359	-987	-3006
Current Account Balance	(a)	-478	-539	-741	-867	-2606
*** Financial ***						
Exchange Rate (US/CAN)		0.00	0.00	0.00	0.00	0.00
Terms of Trade, Goods		0.00	0.03	0.16	0.25	0.25
Prime Comm. Paper Rate	(a)	0.00	0.00	0.00	0.00	0.00
Industrial Bond Rate	(a)	0.00	0.00	0.00	0.00	0.00

(a) Level Impact

Source: Informetrica (1988)

Table E.2

NATIONAL ECONOMIC IMPACT OF SCENARIO B

Scenario B, Sep 6		1989	1990	1993	1998	2005
				% Impact		
*** Gross National Expenditure ***						
Value		0.23	0.14	0.24	0.35	0.36
Price		0.01	0.02	0.33	0.66	0.65
Volume		0.22	0.12	-0.09	-0.31	-0.29
*** Volumes ***						
Consumption Expenditure		0.04	0.04	-0.09	-0.19	-0.14
Durables		0.08	0.06	-0.12	-0.20	-0.12
Other		0.03	0.03	-0.08	-0.18	-0.14
Government Expenditure		0.15	0.12	0.15	0.11	0.27
Current		0.06	0.04	0.08	0.13	0.32
Capital		0.73	0.64	0.54	0.00	0.00
Business Investment		1.15	1.23	0.91	-0.10	0.04
Residential		0.02	0.04	0.09	-0.11	-0.03
Nonresidential		1.53	1.62	1.16	-0.09	0.05
Inventory Change	(a)	132	-15	-62	9	-1
Net Exports	(a)	-239	-266	-403	-433	-663
Exports		-0.08	-0.14	-0.32	-0.42	-0.40
Merchandise		-0.10	-0.16	-0.35	-0.47	-0.45
Services		0.00	-0.02	-0.13	-0.16	-0.12
Imports		0.38	0.37	0.38	0.23	0.45
Merchandise		0.41	0.36	0.29	0.08	0.20
Services		0.30	0.40	0.63	0.67	1.29
*** Labour Market ***						
Labour Force		0.01	-0.01	-0.03	0.01	0.02
Employment		0.14	0.13	0.03	-0.19	-0.12
Unemployment		-1.43	-1.39	-0.61	2.07	1.97
Unemployment Rate (%)	(a)	-0.12	-0.12	-0.05	0.18	0.13
*** Wages and Prices ***						
Wage & Salary/Employee (SC)		0.04	-0.04	0.14	0.50	0.47
Output per Employee (S71)		0.08	-0.01	-0.10	-0.09	-0.11
Priv. Non-Agr Unit Lab. Cost		-0.05	-0.05	0.24	0.59	0.54
Impl. Deflator of Imports		-0.01	-0.03	-0.08	-0.09	-0.07
Implicit Output Deflator		0.03	0.04	0.35	0.67	0.67
Consumer Price Index		0.00	0.00	0.23	0.50	0.50
*** Incomes ***						
Disposable Income/Capita		0.07	0.06	-0.11	-0.18	-0.12
Corporate Profits		0.37	0.01	-0.05	0.61	0.35
Government Balances (Mn SC)						
All-Governments	(a)	529	247	76	-938	-2600
Federal	(a)	465	177	307	4	296
Non-Federal	(a)	70	85	-231	-955	-2901
Current Account Balance	(a)	-760	-804	-980	-851	-2484
*** Financial ***						
Exchange Rate (US/CAN)		0.00	0.00	0.00	0.00	0.00
Terms of Trade, Goods		0.04	0.10	0.33	0.46	0.41
Prime Comm. Paper Rate	(a)	0.00	0.00	0.00	0.00	0.00
Industrial Bond Rate	(a)	0.00	0.00	0.00	0.01	0.00

(a) Level Impact

Table E.3

NATIONAL ECONOMIC IMPACT OF SCENARIO C

Scenario C, Sep 6		1989	1990	1993	1998	2005
				% Impact		
*** Gross National Expenditure ***						
Value		0.10	0.06	0.12	0.18	0.18
Price		0.01	0.02	0.18	0.35	0.34
Volume		0.09	0.05	-0.06	-0.17	-0.16
*** Volumes ***						
Consumption Expenditure		0.01	0.01	-0.06	-0.11	-0.08
Durables		0.03	0.01	-0.09	-0.12	-0.08
Other		0.01	0.01	-0.05	-0.10	-0.08
Government Expenditure		0.08	0.06	0.05	0.02	0.08
Current		0.04	0.02	0.03	0.04	0.10
Capital		0.32	0.27	0.19	-0.03	-0.04
Business Investment		0.48	0.53	0.38	-0.07	0.02
Residential		0.01	0.02	0.04	-0.06	-0.02
Nonresidential		0.64	0.69	0.48	-0.07	0.02
Inventory Change	(a)	56	-10	-33	5	-1
Net Exports	(a)	-99	-113	-176	-204	-326
Exports		-0.02	-0.03	-0.10	-0.15	-0.17
Merchandise		-0.02	-0.04	-0.11	-0.17	-0.19
Services		0.00	0.00	-0.05	-0.07	-0.05
Imports		0.17	0.18	0.21	0.16	0.25
Merchandise		0.19	0.19	0.19	0.10	0.14
Services		0.12	0.17	0.27	0.32	0.63
*** Labour Market ***						
Labour Force		0.00	0.00	-0.02	0.00	0.01
Employment		0.06	0.06	0.01	-0.09	-0.07
Unemployment		-0.66	-0.68	-0.33	1.01	1.13
Unemployment Rate (%)	(a)	-0.05	-0.06	-0.03	0.09	0.08
*** Wages and Prices ***						
Wage & Salary/Employee ($C)		0.02	-0.02	0.06	0.25	0.24
Output per Employee ($71)		0.03	-0.01	-0.07	-0.06	-0.06
Priv. Non-Agr Unit Lab. Cost		-0.02	-0.01	0.13	0.31	0.29
Impl. Deflator of Imports		0.00	0.00	-0.02	-0.03	-0.02
Implicit Output Deflator		0.01	0.02	0.19	0.35	0.35
Consumer Price Index		0.00	0.01	0.12	0.26	0.26
*** Incomes ***						
Disposable Income/Capita		0.02	0.01	-0.08	-0.11	-0.08
Corporate Profits		0.15	0.01	0.02	0.34	0.50
Government Balances (Mn $C)						
All-Governments	(a)	239	124	50	-439	-1244
Federal	(a)	215	100	154	13	150
Non-Federal	(a)	29	40	-103	-463	-1399
Current Account Balance	(a)	-331	-368	-455	-448	-1268
*** Financial ***						
Exchange Rate (US/CAN)		0.00	0.00	0.00	0.00	0.00
Terms of Trade, Goods		0.00	0.02	0.13	0.19	0.19
Prime Comm. Paper Rate	(a)	0.00	0.00	0.00	0.00	0.00
Industrial Bond Rate	(a)	0.00	0.00	0.00	0.00	0.00

(a) Level Impact

Table E.4

NATIONAL ECONOMIC IMPACT OF SCENARIO E

Scenario E, Sep 7		1989	1990	1993	1998	2005
				% Impact		
*** Gross National Expenditure ***						
Value		0.06	0.04	0.08	0.18	0.34
Price		0.00	0.01	0.10	0.27	0.51
Volume		0.05	0.03	-0.02	-0.09	-0.17
*** Volumes ***						
Consumption Expenditure		0.01	0.00	-0.03	-0.07	-0.06
Durables		0.01	0.00	-0.04	-0.08	-0.05
Other		0.01	0.00	-0.02	-0.06	-0.06
Government Expenditure		0.05	0.05	0.07	0.17	0.49
Current		0.02	0.02	0.06	0.17	0.56
Capital		0.19	0.18	0.16	0.15	0.14
Business Investment		0.27	0.29	0.21	0.12	0.02
Residential		0.01	0.01	0.02	-0.01	-0.01
Nonresidential		0.35	0.38	0.27	0.15	0.03
Inventory Change	(a)	31	-5	-16	-11	-32
Net Exports	(a)	-54	-61	-101	-214	-510
Exports		-0.01	-0.02	-0.05	-0.12	-0.22
Merchandise		-0.01	-0.02	-0.06	-0.14	-0.24
Services		0.00	-0.01	-0.03	-0.06	-0.09
Imports		--0.09	0.10	0.12	0.21	0.45
Merchandise		0.10	0.10	0.11	0.15	0.29
Services		0.07	0.10	0.17	0.36	0.97
*** Labour Market ***						
Labour Force		0.00	0.00	-0.01	0.00	0.02
Employment		0.04	0.04	0.01	-0.01	0.01
Unemployment		-0.36	-0.37	-0.20	0.15	0.12
Unemployment Rate (%)	(a)	-0.03	-0.03	-0.02	0.01	0.01
*** Wages and Prices ***						
Wage & Salary/Employee ($C)		0.01	-0.01	0.05	0.19	0.38
Output per Employee ($71)		0.02	0.00	-0.03	-0.07	-0.14
Priv. Non-Agr Unit Lab. Cost		-0.01	-0.01	0.07	0.23	0.45
Impl. Deflator of Imports		0.00	0.00	-0.01	-0.02	-0.03
Implicit Output Deflator		0.01	0.01	0.10	0.28	0.53
Consumer Price Index		0.00	0.01	0.07	0.20	0.36
*** Incomes ***						
Disposable Income/Capita		0.01	0.01	-0.03	-0.07	-0.05
Corporate Profits		0.10	0.01	0.04	0.16	0.20
Government Balances (Mn $C)						
All-Governments	(a)	126	53	-29	-345	-1845
Federal	(a)	125	73	102	176	601
Non-Federal	(a)	8	1	-129	-532	-2449
Current Account Balance	(a)	-181	-205	-279	-622	-2219
*** Financial ***						
Exchange Rate (US/CAN)		0.00	0.00	0.00	0.00	0.00
Terms of Trade, Goods		0.00	0.01	0.06	0.15	0.25
Prime Comm. Paper Rate	(a)	0.00	0.00	0.00	0.00	0.00
Industrial Bond Rate	(a)	0.00	0.00	0.00	0.00	0.00

(a) Level Impact

Source: Informetrica (1988)

APPENDIX F

ONTARIO ECONOMIC IMPACT OF SCENARIO C

Table F.1

ONTARIO ECONOMIC IMPACT OF SCENARIO A

Scenario A Impact, Sept. 6	1989	1990	1993	1998	2005
			% Impact		
Gross Domestic Product (S71)					
Total	0.18	0.03	-0.34	-0.58	-0.47
Agriculture	0.13	-0.05	-0.16	-0.12	0.03
Resource Extraction	-0.37	-0.50	-0.91	-0.56	-0.64
Manufacturing	0.19	-0.15	-0.74	-0.98	-0.94
Electrical Products	0.25	0.06	-0.21	-0.55	-0.58
Motor Vehicles	-0.02	-0.28	-0.58	-0.65	-0.58
Parts & Accessories	0.60	0.37	0.30	0.15	0.09
Primary Metals	-0.19	-1.24	-2.91	-3.22	-3.33
Utilities	0.22	0.20	0.16	-0.05	0.15
Electrical	0.25	0.23	0.22	-0.03	0.11
Comm. & Personal Services	0.07	0.03	-0.16	-0.40	-0.28
Employment					
Total	0.17	0.13	-0.06	-0.29	-0.07
Agriculture	0.10	0.01	-0.17	-0.19	-0.13
Resource Extraction	-0.19	-0.19	-0.29	-0.11	-0.29
Manufacturing	0.23	0.19	0.04	-0.17	-0.03
Durables	0.36	0.36	0.34	0.06	0.09
Nondurables	0.06	-0.02	-0.38	-0.49	-0.22
Utilities	0.16	0.18	0.23	0.10	0.23
Comm. & Personal Services	0.08	0.05	-0.10	-0.29	-0.04
GDP(S71) per employed worker	0.00	-0.10	-0.27	-0.29	-0.40
Investment (S71)					
Nonresidential Structures	1.82	1.90	0.96	-0.46	-0.15
Manufacturing	11.48	12.72	7.59	-1.84	-0.61
Utilities	0.80	0.69	0.28	-0.85	-0.50
Machinery and Equipment	2.24	2.19	1.54	-0.30	-0.16
Residential Structures	0.18	0.23	-0.28	-0.78	0.15
Labour Force	0.07	0.03	-0.08	-0.19	-0.06
Households	0.02	0.03	-0.02	-0.20	-0.11
Unemployment	-1.82	-1.39	-0.38	1.64	0.26
Personal Income per Household (SK)	0.07	-0.04	-0.24	-0.23	-0.20
Labour Income per employed worker (SK)	-0.01	-0.10	-0.20	-0.17	-0.21

Source: Informetrica (1988)

Table F.2

ONTARIO ECONOMIC IMPACT OF SCENARIO B

Scenario B Impact, Aug. 26	1989	1990	1993	1998	2005
	% Impact				
Gross Domestic Product ($71)					
Total	0.35	0.16	-0.30	-0.71	-0.61
Agriculture	0.22	-0.05	-0.21	-0.22	-0.09
Resource Extraction	-0.49	-0.64	-1.15	-0.68	-0.75
Manufacturing	0.45	0.02	-0.71	-1.14	-1.10
Electrical Products	0.54	0.25	-0.13	-0.72	-0.75
Motor Vehicles	-0.37	-1.13	-1.86	-1.87	-1.40
Parts & Accessories	1.62	1.70	1.64	1.26	0.84
Primary Metals	0.22	-0.95	-2.70	-3.18	-3.35
Utilities	0.30	0.20	-0.05	-0.40	-0.18
Electrical	0.33	0.21	-0.04	-0.43	-0.21
Comm. & Personal Services	0.13	0.08	-0.15	-0.52	-0.41
Employment					
Total	0.30	0.26	0.00	-0.40	-0.19
Agriculture	0.17	0.03	-0.22	-0.32	-0.26
Resource Extraction	-0.25	-0.26	-0.46	-0.24	-0.45
Manufacturing	0.42	0.37	0.13	-0.25	-0.08
Durables	0.64	0.63	0.53	0.04	0.13
Nondurables	0.12	0.02	-0.42	-0.65	-0.38
Utilities	0.23	0.22	0.15	-0.11	0.05
Comm. & Personal Services	0.14	0.11	-0.07	-0.38	-0.14
GDP($71) per employed worker	0.04	-0.10	-0.31	-0.32	-0.42
Investment ($71)					
Nonresidential Structures	2.73	2.95	1.77	-0.52	-0.17
Manufacturing	15.98	18.08	12.18	-1.75	-0.67
Utilities	2.10	1.96	1.29	-1.11	-0.59
Machinery and Equipment	4.48	4.35	3.24	-0.13	-0.06
Residential Structures	0.37	0.57	-0.04	-1.04	0.20
Labour Force	0.13	0.10	-0.03	-0.21	-0.08
Households	0.03	0.07	0.05	-0.20	-0.12
Unemployment	-2.96	-2.23	-0.61	3.12	3.46
Personal Income per Household ($K)	0.16	0.00	-0.27	-0.31	-0.31
Labour Income per employed worker ($K)	0.00	-0.10	-0.23	-0.19	-0.28

Source: Informetrica (1988)

Table F.3

ONTARIO ECONOMIC IMPACT OF SCENARIO C

Scenario C Impact, Aug. 29	1989	1990	1993	1998	2005
			% Impact		
Gross Domestic Product ($71)					
Total	0.11	0.00	-0.28	-0.47	-0.42
Agriculture	0.10	-0.03	-0.12	-0.08	0.02
Resource Extraction	-0.28	-0.35	-0.56	-0.26	-0.28
Manufacturing	0.11	-0.14	-0.59	-0.78	-0.76
Electrical Products	0.15	0.01	-0.19	-0.42	-0.42
Motor Vehicles	-0.03	-0.22	-0.44	-0.49	-0.43
Parts & Accessories	0.43	0.28	0.22	0.12	0.08
Primary Metals	-0.44	-1.51	-3.32	-3.56	-3.74
Utilities	0.18	0.19	0.22	0.05	0.12
Electrical	0.22	0.24	0.33	0.15	0.22
Comm. & Personal Services	0.05	0.01	-0.13	-0.32	-0.27
Employment					
Total	0.12	0.08	-0.06	-0.25	-0.15
Agriculture	0.07	0.01	-0.12	-0.13	-0.08
Resource Extraction	-0.19	-0.21	-0.39	-0.29	-0.42
Manufacturing	0.18	0.18	0.13	-0.01	0.09
Durables	0.26	0.28	0.33	0.17	0.22
Nondurables	0.07	0.04	-0.15	-0.26	-0.10
Utilities	0.12	0.15	0.20	0.08	0.11
Comm. & Personal Services	0.05	0.02	-0.12	-0.30	-0.21
GDP($71) per employed worker	0.00	-0.09	-0.22	-0.22	-0.26
Investment ($71)					
Nonresidential Structures	1.20	1.25	0.58	-0.35	-0.14
Manufacturing	8.17	9.06	5.50	-1.29	-0.46
Utilities	0.02	-0.05	-0.26	-0.56	-0.34
Machinery and Equipment	1.60	1.57	1.09	-0.25	-0.14
Residential Structures	0.12	0.14	-0.25	-0.61	0.04
Labour Force	0.04	0.01	-0.08	-0.16	-0.09
Households	0.01	0.02	-0.02	-0.16	-0.11
Unemployment	-1.28	-1.02	-0.34	1.39	1.87
Personal Income per Household ($K)	0.05	-0.04	-0.20	-0.20	-0.20
Labour Income per employed worker ($K)	-0.02	-0.08	-0.18	-0.14	-0.19

Source: Informetrica (1988)

Table F.4

ONTARIO ECONOMIC IMPACT OF SCENARIO E

Scenario E Impact, Sept. 6	1989	1990	1993	1998	2005
			% Impact		
Gross Domestic Product ($71)					
Total	0.07	0.01	-0.13	-0.34	-0.54
Agriculture	0.06	0.00	-0.05	-0.05	-0.03
Resource Extraction	-0.08	-0.12	-0.27	-0.42	-0.66
Manufacturing	0.07	-0.06	-0.29	-0.63	-1.03
Electrical Products	0.10	0.03	-0.07	-0.28	-0.61
Motor Vehicles	-0.02	-0.13	-0.24	-0.43	-0.57
Parts & Accessories	0.24	0.16	0.14	0.15	0.03
Primary Metals	-0.12	-0.56	-1.25	-2.46	-3.86
Utilities	0.09	0.08	0.07	0.03	0.08
Electrical	0.10	0.10	0.10	0.05	0.05
Comm. & Personal Services	0.03	0.01	-0.07	-0.21	-0.33
Employment					
Total	0.06	0.05	-0.03	-0.13	-0.15
Agriculture	0.04	0.02	-0.05	-0.04	-0.03
Resource Extraction	-0.05	-0.04	-0.08	-0.09	-0.19
Manufacturing	0.08	0.07	0.02	-0.03	-0.04
Durables	0.13	0.13	0.13	0.13	0.15
Nondurables	0.02	-0.01	-0.14	-0.26	-0.32
Utilities	0.06	0.07	0.09	0.09	0.16
Comm. & Personal Services	0.03	0.01	-0.05	-0.16	-0.16
GDP($71) per employed worker	0.00	-0.04	-0.10	-0.21	-0.39
Investment ($71)					
Nonresidential Structures	0.69	0.72	0.37	0.07	-0.21
Manufacturing	4.47	4.89	3.03	1.56	-0.61
Utilities	0.25	0.20	0.06	-0.33	-0.49
Machinery and Equipment	0.87	0.84	0.62	0.28	-0.15
Residential Structures	0.06	0.07	-0.14	-0.47	-0.32
Labour Force	0.02	0.01	-0.04	-0.12	-0.15
Households	0.01	0.01	-0.01	-0.09	-0.16
Unemployment	-0.70	-0.55	-0.23	0.22	-0.18
Personal Income per Household ($K)	0.03	-0.02	-0.09	-0.16	-0.21
Labour Income per employed worker ($K)	-0.01	-0.04	-0.08	-0.13	-0.19

Source: Informetrica (1988)

APPENDIX G

CONSEQUENCES FOR INDIVIDUAL SECTORS

CONSEQUENCES FOR INDIVIDUAL SECTORS

The costs of complying with the proposed revisions will not be the same for all firms in the same sector unless the firms are of similar size, produce similar contaminants and have similar options for abatement. Differences in raw materials, production technologies, products and abatement measures already undertaken may each contribute to differences in the effect of the revised regulation on firms in the same sector. Other differences pertaining to market conditions and ownership may also help to determine the effect of the revised regulation on otherwise similar firms.

In order to understand more fully the likely economic consequences, an attempt was made to identify firms and categories of firms which would have the greatest financial difficulty. An approach was developed whereby a "degree of difficulty" parameter, ranging from 0 to 3, was assigned a priori to each industry or sector:

- The number "0" was accorded to industries that would not face any incremental compliance costs.
- The number "1" was accorded to industries where significant financial difficulties were not expected.
- The number "2" was accorded to industries where there seemed to be a possibility of some financial difficulties.
- The number "3" was accorded to industries for which significant financial difficulty was expected.

This exercise was conducted with the assistance of industry representatives, government officials and other persons with extensive knowledge of the industry. Factors that were considered included:

- size and ownership of companies;
- current and expected profitability;
- sales price, production cost and profit margins;
- competitiveness and whether Ontario firms were price takers or price setters;
- future outlook for the industry;
- technological innovativeness of the industry.

In general, the sectors that were categorized as "2" or "3" were selected as requiring further, more detailed analysis. The sectors selected for further detailed analysis are shown in Table G-1, along with three indicators of their importance to the Ontario economy. Although the public sector would also have to bear significant costs in complying with and administering the proposed revisions to Regulation 308, presumably these costs will be spread over the tax base and will therefore not pose a significant problem for the public sector or taxpayers.

Summary of Consequences for Affected Sectors

Dairy (SIC 1049): The only segment of the Ontario dairy industry that will be affected by the proposed revisions to Regulation 308 is whey powder production. Eight firms are involved, none of which relies on sales of whey powder as its sole source of income. Costs of compliance were estimated for the cheese manufacturing industry as a whole; the cost of compliance specifically related to whey drying is not available. No firm conclusions can be drawn then, about the impact of the proposed regulatory changes on firms engaged in this activity.

Restaurants (SIC 9211-9213): The restaurants in Ontario which produce emissions that would be affected by the revised regulation are those which use charcoal. These constitute about 1% of all restaurants in Ontario and have about 1,000 full-time-equivalent employees. Costs of approximately $76,000 per restaurant for abatement and monitoring equipment and about $6,500 per year for operations and maintenance would accrue to these businesses under the proposed revisions.

Franchised operators and independent operators would both be affected. Independent operators can be expected to have considerable difficulty in meeting compliance costs which would total, on average, about $6,000 per year calculated on a uniform annual cost basis. The franchisees may be in a somewhat better position, but it is possible that additional costs would result in the elimination of commercial charcoal-burning food preparation in Ontario.

Pulp and Paper: The pulp and paper sectors identified for further study are kraft pulp mills, newsprint mills with kraft pulp and sulphite pulp, and paperboard mills with kraft pulp.

Kraft Pulp Mills (SIC 2711): This sector, which employs over 7,200, is in a strong financial position. Estimated compliance costs represent 1 - 2% of profits, estimated on the basis of recent production costs

Table G-1: Sectors of Interest

SIC	Industry	Number of Plants	Employment	Annual Production at Capacity
049	Other Dairy	94	4,864	107,529 tonnes cheese
	sector affected by regulation: whey powder production	NA	NA	NA
2711	Kraft pulp mills	9	7,207	946,200 tonnes pulp
2712	Newsprint mills	11	6,189	119,500 tonnes newsprint
	sectors of interest: newsprint mills with kraft pulping	2	NA	1,107,000 tonnes
	newsprint mills with sulphite pulping	3	NA	460,000 tonnes
2713	Paperboard mills	16	2,737	751,000 tonnes paperboard
	sector of interest: paperboard mills with kraft pulping	2	1,154	587,000 tonnes
2911	Ferroalloy	1	16	1,350 tonnes
2912	Steel foundries	24	41,409	12,686,200 tonnes
2941	Iron foundries	61	7,110	1,584,180 tonnes
2959	Non-ferrous smelters	16	8,111	829,314 tonnes
2971	Copper and brass works	23	2,149	78,400 tonnes
2999	Rolled casting	63	5,623	75,529 tonnes
3231	Automotive and light duty truck surface coating	212	1,895	2,162,200 vehicles
3259	Wet cell automotive battery production	8	877	7,365,120 batteries
3511	Domestic clay	26	1,405	1,593,000 tonnes

Table 6-1: continued

3611 Petroleum refineries	NA	NA	NA
3699 Asphalt plants	150	1,208	84,300,000 tonnes
Affected by regulation: portable plants with venturi systems	20	200	12,300,000 tonnes
3712 Organic chemicals	37	7,114	878,720 tonnes
3791 Printing ink	40	1,693	63,830 tonnes
3799 Other chemicals	188	9,891	420,327 tonnes
9211 Restaurants	15,000	75,000	NA
9213 sector of interest: charcoal-burning restaurants	200	1,000	NA
9721 Dry cleaning clothing	1,200	12,000	36,000 tonnes

and selling prices. However, the market is highly cyclical and intensely competitive. Ontario operations are by and large in need of capital-intensive modernization; additional abatement and monitoring costs can therefore be expected to affect the rate at which new technology is brought on stream in this sector.

Newsprint Mills (SIC 2712): The newsprint sector is currently healthy, a situation which may not last if recent competitive pressures continue to mount. The estimated compliance costs for both kraft pulp and sulphite pulp newsprint mills represent up to 2% of recently reported per tonne profits. Newsprint mills in Ontario currently hold a sizeable portion of the U.S. market. These exports are very important to the industry and are dependent on the continued competitiveness of Ontario mills.

Paperboard Mills with Kraft Pulping (SIC 2713): Compliance costs are less than 1% of recent selling prices and reported profits. On this basis, the impact of compliance for this sector does not appear to be as great as for other components of the pulp and paper sector.

Ferro-alloy Industry (SIC 2911): There is only one ferro-alloy company in Ontario. The estimated compliance costs are less than 0.5% of the current selling price of the final product. While this cost is not negligible, it is likely that the future of this 16-employee firm will be determined by market events over the near term, particularly the security of supply of raw materials.

Foundries (SIC 2912, 2941): There are 61 iron foundries in Ontario, with just over 7,000 employees; steel foundries number 24 and provide jobs for 41,000 people. Most plants are small, so that this sector is characterized by low profit margins and strong competition, although there are exceptions. Any additional costs not borne by competitors in the rest of Canada and the U.S. can be expected to have serious consequences on Ontario-based companies. For example, compliance costs for ferrous foundries are estimated to be the equivalent of 26% of recent representative profit levels.

Non-Ferrous Smelters (SIC 2959): The metals industry in Canada is fiercely competitive. A significant proportion of shipments are exported, and Canadian producers prices are set in the global marketplace. Compliance costs for scenarios A and B represent between 0.8 and 1% of the selling prices of copper and aluminum, 15% of the selling price of nickel, 0.01% of the selling price of silver, and 1.9% of the selling price of zinc. The costs for scenario C are about 70% of those for scenarios A and B. These compliance costs will have measurable effects on non-ferrous smelters and the 8,100 people they employ in the province.

Auto Surface Coating (SIC 3231): There are 212 automotive and light-duty-truck surface-coating plants in Ontario employing some 2,000 people. The uniform annual costs of compliance, calculated on a per car painted basis, would be $6.00 under scenario A, $21 under scenario B, and $5 under scenario C (the cost of painting a vehicle at present is about $125). Although the industry is currently prospering, it is facing large re-structuring and adjustment costs to meet international competition. However, there are indications that other, cheaper means of meeting the revised regulation may soon be available, such as the use of water based paints, which would substantially reduce the compliance costs for automotive plants.

No detailed analysis was performed of the impact of the proposed revisions to Regulation 308 on independent automotive paint shops. If their costs are similar to those of dedicated plants, they will be in a position to pass any such costs on to their customers.

Automotive Batteries (SIC 3259): The costs of compliance for this sector, which employs nearly 900 Ontarians, are about 1% of current production costs, or in (1986) money terms, somewhat less than 30 cents per battery. Even cost increases of this size can translate into a significant drop in profits if the margins are small. Battery manufacturers that produce for single buyers may be able to pass on at least part of the increased costs, but independent firms serving the replacement battery market may have difficulty in either absorbing the increased cost or passing it on to their customers.

Domestic Clay Products (SIC 3511): Several subsectors were identified for further analysis: bricks, drainage tiles, clay sewer pipes, floor and wall tiles, clay flower pots and filter tile. In total, 1,400 employees at 26 plants are involved.

Bricks: Compliance costs represent 1.7 - 2.2% of the price of bricks. Brick producers are facing competition from other materials, and any significant compliance costs may affect the competitiveness of the brick industry. Concrete bricks can be produced more cheaply and have already captured about 20% of the market.

Drainage Tile: Many Ontario drainage tile plants have closed in recent years because of the declining market for clay drainage tiles. Compliance costs of $2.30 to $2.90 per tonne not borne by substitute products and/or foreign competitors could be expected to have significant adverse effects on the companies in this sector.

Clay Sewer Pipe: The use of clay sewer pipe has declined dramatically with the advent of cheaper plastic pipe. Clay pipe is now produced by only one company in Ontario; even for this firm, clay pipe is not a substantial product line owing to consistently weak sales. These sales would decline even further with a requirement for compliance costs of $2.30 to $2.90 per tonne.

Floor and Wall Tile: The floor and wall tiles industry faces strong competition from other producers worldwide. Competitiveness of the industry is an important factor, since a significant proportion of shipments in the Ontario industry are exported. Compliance costs of $2.30 to $2.90 per tonne may be a burden to the industry.

Clay Flower Pots and Filter Tile: The only producer of these products in Canada is in Ontario. Although cheaper plastic products now dominate the market, clay retains a 20% share because of its aesthetic appeal. Compliance costs of $2.30 to $2.90 per tonne may reduce this market share still further.

Cement (SIC 3521): The five cement companies in Ontario employ nearly 2,100 people. They have been modernized and lead the North American industry in energy and operating efficiency. Estimated compliance costs represent between 0.2 and 0.4% of the recent selling price for grey cement and 0.1 and 0.2% for white cement. Ontario producers of grey cement export significant quantities of output (about 25%) to the U.S. Increased compliance costs may, therefore, harm export sales.

The market for white cement is entirely different in that competition is based on quality rather than price. Ontario's single white cement producer may be able to pass on increases in costs to its customers.

Lime (SIC 3581): About 900 people are employed at nine lime producing plants in the province. Compliance costs represent 36 cents per tonne under scenarios A and B and about 26 cents per tonne under scenario C. These costs correspond to less than 1% of the recent selling prices. However, the lime production industry is very competitive. Since Ontario producers export approximately 11% of total shipments, compliance costs could affect the industry.

Petroleum Refineries (SIC 3611): Ontario's seven refineries employ just over 2,100 people and account for about 35% of the refinery capacity in Canada. Compliance costs are equivalent to approximately $1.10 per tonne under scenario A, $1.30 per tonne under scenario B and $0.50 per tonne under scenario C. The costs represent about 7.3% of profit margins under scenario A, 8.7% under scenario B and 3.3% under scenario C. These percentages are considerably lower than those implied by the estimates of cost as a percentage of value added shown in Table 4.1 Although both sets of estimates suggest that the compliance costs would have serious consequences for the petroleum refining industry, the situation may not be as acute as the more aggregate data in Table 4.1 indicate.

Asphalt Plants (SIC 3699): Of the 25 portable asphalt plants in the province, 20 are not equipped with baghouses to control air emissions. The cost of adding this equipment to meet the requirements of a revised Regulation 308 would be about 0.5% of current selling price, or 3.8% of typical profits.

Organic Chemicals (SIC 3712): There is such a variety of products produced by the organic chemicals industry that it is difficult to draw any conclusions about the impact of compliance costs on the profitability of the sector. Annual compliance costs appear to represent between 0.05% and 1.1% of total 1987 revenues for a sample of companies for which financial information was obtained, but no clear picture emerges as to how well firms will cope with these costs.

Printing Ink (SIC 3791): About 40 plants, employing some 1,700 people produce printing ink in Ontario. Compliance costs are between approximately 1.2% and 2.4% of the typical selling prices in this sector. Most of the product is sold in Ontario; if all printing ink companies in the province face similar compliance costs, a substantial portion of these costs will be passed on to consumers.

Other Chemical Products (SIC 3799): The 188 companies that make up this sector vary tremendously in most respects, and they produce a wide variety of products. As with organic chemicals, it is impossible to draw any conclusions about the financial difficulties that might be experienced by this industry as a whole.

Dry Cleaning (SIC 9721): There are approximately 1,200 dry cleaning plants in Ontario employing some 12,000 people. About half are central plants, and half are located on site at individual dry cleaning outlets. The cost for compliance would be between 4.2 and 4.5% of average per tonne revenue under scenario A, 5.4 and 5.7% under scenario B, and 1.5 and 1.6% under scenario C. According to industry sources, these costs represent between 13 and 56% of normal profits, suggesting that all three scenarios pose major difficulties for the dry cleaning industry. Much lower cost options are available involving "house-keeping" measures are available but these would be insufficient to meet the proposed regulation.

Private Waste Incineration: A total of three private firms currently incinerate waste in Ontario, only one of which disposes of "hazardous" waste. The uniform annual cost of compliance is $5.00 for scenarios A and B, and $2.00 for scenario C. While these costs are small proportions of the average per tonne charge for waste disposal, it should be borne in mind that the up-front capital costs ($917,000 for scenarios A and

B, and $367,000 for scenario C) would be considerable for smaller firms